A STUDY OF THE LOCOMOTIVE WATER SUPPLY SITUATION ON THE MAIN LINE OF THE NEW YORK CENTRAL RAILROAD WITH RESPECT TO THE UTILIZATION OF LARGER TENDERS AND THEIR RELATION TO TRACK PAN LOCATION

A Thesis

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Might of the roaring boiler,
Force of the engine's thrust,
Sweat of the toiling worker,
In all these things we trust.
But back of them, the dreamer,
Thinking the problem through;
Back of them all, the schemer,
Making the dream come true.

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PREFACE

The investigation covered by this thesis extended over a period of some two years and involved the collection, compilation, and summarization of innumerable data from which conclusions herein were drawn. If an attempt were made to describe every minute detail and every source of information, this thesis would become a highly detailed and complicated story of the operation, financing, and engineering involved in a modern railroad, which, of course, is impossible within the scope of these pages. However, in order to be of assistance to the reader who may not be thoroughly familiar with some of the essential features of operation, it may be well to roughly outline them.

Territory Covered

The territory covered by this study consists of the main line Divisions of the New York Central Railroad between New York and Chicago and certain branch line Divisions using locomotives jointly with contiguous main line Divisions. The railroad is divided into two major operating districts, Line East and Line West of Buffalo, N.Y. Between Harmon, N.Y. and Grand Central Terminal (33 miles) the road is electrified and passenger traffic is moved with electric locomotives.

Locomotive Assignment.

Passenger Service.

At the time of the study, passenger traffic on the Line East was handled with 226 K-2 and K-3 Pacific type locomotives operating between

Harmon and Buffalo (406 miles) and on the Line West with 140 locomotives of similar type operating between Buffalo and Chicago (522 miles). Five of the Line East locomotives were equipped with 16-ton - 10,700-gallon tenders; the remainder of the Line East and all of the Line West locomotives were equipped with 12-ton - 7500 or 8000-gallon tenders.

Locomotive Assignment

Freight Service

Freight engines handling fast and slow freight trains were operated between Divisions Terminals as follows:-

Hudson Division

Between 72nd St., New York and Selkirk Yard (Albany).

Mohawk Division

Between Selkirk Yard and Dewitt Yard (Syracuse).

Syracuse Division

Between Dewitt Yard and Buffalo.

Between Dewitt Yard and Suspension Bridge

Erie Division

Between Buffalo and Collinwood (Cleveland)

Between Buffalo and Youngstown

Cleveland Division

Between Collinwood and Air Line Jct. (Toledo).

Toledo Division

Between Air Line Jct. and Elkhart.

Western Division

Between Elkhart and Englewood (Chicago)

Between Elkhart and Gibson, Ind. (Near Chicago).

The distribution of these engines was as follows:-

Hudson Division

25 H-5 Mikados, 11 of which were equipped with 18-ton - 15,000-gallon tenders and the remaining 14 with 12 or 14-ton - 8,000-gallon tenders.

Mohawk and Syracuse Divisions

100 Class L-2 Mohawk Type with 21-ton - 15,000-gallon Tenders.

111 Class L-1 Mohawk Type with 18-ton - 15,000-gallon tenders.

Erie and Cleveland Divisions

5 Class H-10a Mikados with 18-ton - 15,000-gallon tenders.

105 " " " " 16-ton - 10,000-gallon tenders.

50 " H-10b " " 18-ton - 15,000-gallon tenders.

Toledo and Western Divisions

74 Class L-1 Mohawk Type with 14-ton - 8,000-gallon tenders.

Photographs of the various locomotives involved may be found on Pages 87-94 Section (E).

COMPLICATIONS - LINE EAST

A study of the operation of the Mohawk and Syracuse Divisions was complicated to the extent that a part of the freight traffic on these two Divisions was moved via West Shore, a double track freight railroad paralleling the main line; a part via Rochester and the Falls Road to and from Suspension Bridge; and a part via Lyons to and from Buffalo, Syracuse, Suspension Bridge, and Corning, N.Y. Further complications arose on account of the fact that tracks 3 and 4 on the main line and the West Shore normally used for freight traffic, were not equipped with track pans. This necessitated a close study of train sheets to trace the routing of each freight train over its respective Division.

COMPLICATIONS- LINE WEST

The H-10 locomotives operated jointly over the Erie, Cleveland, and Franklin Divisions.

Some of the L-1 engines operating on the Toledo and Western Divisions also operated on the latter Division to and from Gibson, Ind., branching off just East of Gary, Ind.

LOCAL FREIGHT SERVICE

Local freight service was not included in this study because water stop delays to such trains are not an acute problem and do not increase the cost of operation in the same proportion as in the case of fast and slow freight trains.

ILLUSTRATIONS

In the latter part of the thesis has been included a map of the New York Central Lines, a layout of track pans and coaling stations, photographs of locomotives, slope sheet coal pushers, tender trucks, water scoops, etc. It is thought that this will be of material assistance to a clearer understanding of the text.

ACKNOWLEDGEMENTS

Grateful acknowledgement is made to Messrs. F.H. Hardin, Asst. to the President and P.W. Kiefer, Chief Engineer of Motive Power and Rollings Stock, -New York Central Lines, for their valuable assistance in the matter of suggestions and criticisms.

A STUDY OF THE LOCOMOTIVE WATER SUPPLY SITUATION ON THE MAIN LINE OF THE NEW YORK CENTRAL RAILROAD WITH RESPECT TO THE UTILIZATION OF LARGER TENDERS AND THEIR RELATION TO TRACK PAN LOCATION

Introduction

The original object of this study was to determine if the purchas of 15,000-gallon tenders for freight service would permit the removal of any track pans on the main line between New York and Chicago. It was found later that passenger service, freight service, tender sizes, and location and length of track pans were all so closely related that one of these factors could not be considered independently of the others. Therefore, this investigation has been divided into five major sections, outlined as follows:-

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On the pages immediately following are outlined the conclusions drawn from the data contained within the body of the report.

SUMMARY AND CONCLUSIONS

(a) Elimination on Line East or West of any existing track pan station at the present time and with present tenders would result in increased operating costs and detrimental effects upon freight and passenger train operation. See Page No.9.

(b) The removal of any track pan on Line East or West except Schodack and Schenectady would be detrimental to freight service even though all main line freight locomotives were equipped with 15,000-gallon tenders. See Page 11.

(c) If all main line passenger locomotives operating over Line East were equipped with 10,700-gallon tenders, the pans at Schodack and Schenectady could be eliminated with an estimated annual saving of approximately $18,700.00 on track pan maintenance only, and without detrimental effect upon freight train operation.

(d) Application of 15,000-gallon tenders ot the 105 Line West H-10a engines now operating in the Erie-Cleveland- Franklin Division pool, and the transfer of the 10,000-gallon tenders thus released to a like number of the 140 main line passenger locomotives operating on Line West where the larger passenger tenders may be utilized to the best advantage, should result in a net annual saving of approximately $166,000.00 and the return of the investment in about 7¾ years, exclusive of the value of the 7500 and 8000-gallon tenders released and without credit for the improvement in freight and passenger train operation. See Page 13.

(e) Application of 15,000-gallon tenders to 74 Line West L-1 locomotives now operating on the Toledo and Western Divisions should result in a net annual saving of approximately $150,000.00 and the return of the investment in about 5¾ years, exclusive of the benefit derived from the use of these tenders on the Detroit Branch of the Toledo Division and the main line of the Michigan Division via Adrian and Hillsdale; the

value of the 8000-gallon tenders released; and the cost of probable additional engine terminal facilities to handle the 15,000-gallon tenders. See Page 13.

(f) Application of 15,000-gallon tenders to 14 additional H-5 locomotives in order to provide with larger tenders all of the 25 engines of this class required for operation on the Hudson Division should result in a net annual saving of approximately $ 65,000.00 and the return of the investment in approximately 2¾ years, exclusive of the value of the small tenders released. See Page 16.

(g) Although paragraph (d) above jusitifies the transfer of the 105 H-10a 10,000-gallon tenders to Line West Passenger Service, the purchase outright of new 10,700-gallon tenders for the remaining 35 Line West K-2 or K-3 engines or the 226 Line East K-2 or K-3 engines appears inadvisable. However, the use of 10,700-gallon tenders back of all main line passenger motive power should eliminate on Line East and West all normal coal and water stops except the coal stop at Elyria, both directions, and approximately 50% of the water stops at Air Line Junction, Westward. The elimination of some 40,250 passenger train stops annually indicates what could be accomplished by a progressive program of tender changes on these locomotives. Upon electrification of the Cleveland Passenger Terminal, the coal stop at Elyria should also be eliminated.

SECTION -A-

FUNDAMENTAL CONSIDERATIONS

It has been found advisable to provide an operating margin of 3,000 gallons in passenger service as a factor of safety to take care of the numerous items that vary the water consumption from day to day. To encroach upon this margin would result in frequent delays to passenger trains. For example:- Results obtained with the Dynamometer Car in August 1925 indicate that an average 12-car passenger train handled by a K-2 or K-3 Pacific Type locomotive with 7,500-gallon tender should go Eastbound from the track pan at Seneca River to the track pan at Rome with a margin of about 2,400 gallons, but in actual service it is occasionally necessary to cut out a passenger engine at Syracuse on account of insufficient water to take the train to Rome. For similar reasons, an attempt to remove track pans to provide exactly the water consumption indicated by the Dynamometer Car tests would decrease the assurance of uninterrupted passenger service and would be an unwise policy, where the benefit of the pans it is proposed to remove would pay for their maintenance from a freight operating standpoint.

An operating margin of 3,000 gallons in freight service has been provided for in this study, however, this margin will not, in all cases, forestall a stop for water. The water consumption in freight service is greater than that in passenger service and as no definite schedule can be maintained, the engine crews, when passing up a water plug, are not so sure when the next opportunity to take water will present itself. Hence, engine crews will often stop a freight train for water with 4,000 or more gallons of water in the tender, especially on Line East of Buffalo where there are no pans in the tracks normally used for freight service.

A water stop in freight service was found to cause an average delay of 30 minutes at an estimated cost of $25.22 per hour delay for an 80-car train. To be conservative, a figure of $20.00 an hour was used or, $10.00 per stop. This figure, however, does not include the cost of delays to following trains or other complications arising from stopping freight trains for water. The method of computation may be found on Page 66.

A figure of $5.00 was used as the cost of stopping a passenger train for coal or water, however, this figure may be misleading because the numerous ways in which a railroad can be affected by having frequent delays to passenger trains cannot be estimated with any degree of accuracy. The $5.00 includes only the effect upon operating costs, but does not include the effect upon revenue, such as,- refund of extra fare or possible decrease in business caused by delays resulting from frequent coal and water stops. Detailed estimate covering the $5.00 figure may be found on Page 67.

COAL AND WATER REQUIREMENTS

PRESENT TRACK PAN ARRANGEMENT

Passenger Service

Results found with the Dynamometer Car attached to Trains 40, 41, 150, and 151 during August 1925 revealed that with the present track pan arrangement the following tender capacities would be necessary to avoid stopping passenger trains for coal and water:

Note:- "Operation Between " indicates terminals between which passenger locomotives under present and proposed operating conditions would normally run.

Operation Between	Coal Requirements	Water Capacity Including 3000 Gal. Operating Margin
Harmon and Buffalo	18 Tons	9,000 Gallons.
Buffalo " Chicago	25 "	10,700 "
Harmon " Syracuse	12 "	8,000 "
Syracuse " Cleveland	15 "	8,000 "
Cleveland " Chicago	18 "	10,700 "

Detail water consumption figures in passenger service between New York (Harmon) and Chicago may be found on Pages 21 and 22.

COAL AND WATER REQUIREMENTS

PRESENT TRACK PAN ARRANGEMENT

Freight Service

Freight train water requirements average from approximately 23,000 to 40,000 gallons per division trip; the detail figures for the various main line divisions may be found as listed below:-

Freight train coal requirements were not obtained except by general observations while making the track pan study. These observations suggest that future 15,000-gallon tenders should be of 24 tons coal capacity, an amount sufficient to avoid stopping the majority of freight trains between Division Terminals for coal.

In SECTION -B-; Track Pan Elimination, no credit was taken for saving in fuel on the assumption that the total water consumed on the railroad would not decrease and hence the load at other plants would increase. No credit was taken for fixed charges of present track pan facilities because the investment in present facilities represents money already spent and which cannot now be returned. At Schenectady, Silver Creek, Grismore, and Chesterton, no credit was claimed for the removal of the pumping plant and water plugs because of the enginehouse at Schenectady, and because present freight service would require that the water plugs at Silver Creek, Grismore, and Chesterton be retained.

Sketch A showing the location of track pans and coaling stations on tracks 1, 2, 3, and 4 between 72nd Street, New York City, and Chicago has been included for reference. This sketch will be found on Page 75.

SECTION -B-

TRACK PAN ELIMINATION

Proposition 1.

Possible elimination of track pans permitted by the present 7,500 or 8,000-gallon passenger tenders and the resultant effect upon freight service using present freight locomotive tenders.

Present passenger service using 7,500 and 8,000-gallon tenders should permit the elimination of the four track pan stations enumerated below, but on account of the necessity of making 18,912 additional water stops annually in freight service as a result of such elimination, an estimated net operating loss of $126,852 would ensue. In addition passenger operation would be reatrded to some extent due to the increased number of freight trains stopping for water.

The $126,852 loss would be distributed as follows:

Pans Removed	Additional Freight Train Stops	Net Annual Operating Loss	Remarks
Clinton Point	1,095	$ 256.00	
Herkimer	3,815	20,183.00	
Wende	1,738	1,530.00	Pass. Engs. Cut Off at Bflo.
Silver Creek	12,264	104,883.00	" " " " " "
Total	18,912	$ 126,852.00	

The operation of passenger locomotives Harmon-Syracuse; Syracuse-Cleveland; and Cleveland-Chicago would not permit the removal of the pans at Wende and Silver Creek. Data supporting the above may be found on Page 20.

Proposition 2.

Possible elimination of track pans permitted by 10,700-gallon tenders on all locomotives in main line passenger service and the resultant effect upon freight service with present freight tenders; the cost and benefit, other than track pan elimination, of the 10,700-gallon tenders has been considered under Propositions 8 and 9 in SECTION -C-.

Presupposing all main line K-2 and K-3 passenger locomotives equipped with 10,700-gallon tenders and the present practice of cutting engines off at Buffalo, it should be possible to eliminate the nine track pans enumerated below, but on account of the necessity of making 38,229 additional water stops in freight service annually, an estimated net operating loss of $266,454.00 would result; and in addition passenger train operation would be retarded to some extent due to the increased number of freight trains stopping for water. The $266,454.00 loss does not include the carrying charges of the investment in 10,700-gallon

tenders and would be distributed as follows:-

Pans Removed	Additional Freight Train Stops	Net Annual Operation Gain	Loss	Remarks
Clinton Point	1,095		$ 256.00	
Schodack	----	$ 10,700.00		
Schenectady	----	8,000.00		
Herkimer	3,815		20,183.00	
East Palmyra	3,267		16,820.00	
Wende	1,738		1,530.00	Pass. Engs. Off at Bflo.
Silver Creek	12,264		104,883.00	" " " " " "
Grismore	6,979		60,281.00	
Chesterton	9,071		81,201.00	
Total	38,229	$ 18,700.00	$285,154.00	
			18,700.00	

Estimated net annual LOSS..... $ 266,454.00

As previously stated, the operation of passenger locomotives Harmon-Syracuse; Syracuse-Cleveland; Cleveland-Chicago would not permit the removal of the pans at Wende and Silver Creek. It will also be noted that the pans at Schodack and Schenectady are the only pans that show a direct saving due to elimination. These pans will be further considered under Proposition 4. Data supporting Proposition 2 may be found on Page 30.

Proposition 3

Possible elimination of track pans permitted by 10,700-gallon passenger tenders and the effect upon freight service with 15,000-gallon tenders. The cost and benefit, other than track pan elimination, of the 10,700-gallon tenders will be considered under Propositions 8 and 9.

Proposition 3 is the same as Proposition 2 except that all freight tenders are assumed to be of 15,000 gallons water capacity.

Assuming all main line freight locomotives equipped with 15,000-gallon tenders, the additional freight service water stops caused by the elimination of the nine track pans enumerated below and permitted by the 10,700-gallon passenger tenders would be reduced from 38,229 to 24,220 annually and the estimated net annual operating loss ensuing would be reduced from $266,454.00 to $126,155.00. This does not include the expenditure for the tenders involved. The loss of $126,155.00 would be distributed as follows:

Pans Removed	Additional Freight Train Stops	Net Annual Operation Gains	Loss	Remarks
Clinton Point	3,976		$ 29,006.00	
Schodack	----	$ 10,700.00		
Schenectady	----	8,000.00		
Herkimer	3,815		20,183.00	
East Palmyra	3,267		16,820.00	
Wende	1,738		1,530.00	Pass. Engs. cut off at Buffalo
Silver Creek	3,271		14,500.00	" " "
Grismore	3,964		30,135.00	
Chesterton	4,189		32,381.00	
Total	24,220	$ 18,700.00	$ 144,855.00	
			18,700.00	

Estimated net annual LOSS.....$ 126,155.00

As stated in Propositions 1 and 2, the operation of passenger engines through and beyond Buffalo would not permit the removal of the pans at Wende and Silver Creek. Supporting data may be found on Page 37.

Proposition 4.

Possible elimination of track pans that would have no detrimental effect upon freight service; 10,700-gallon passenger tenders assumed.

It will be noted from Propositions 2 and 3 that the pans at Schodack and Schenectady may be removed without detrimental effect upon freight service, provided passenger engines are equipped with 10,700 gallon tenders. The estimated reduction in operating expense of $18,700.00 annually realized through the removal of these pans would be more than offset by the carrying charges on 226 10,700-gallon passenger tenders. The other benefits to be derived from the use of the larger tenders will be further considered under Propositions 8 and 9. Supporting data for Proposition 4 may be found on Page 42.

SECTION -C-

TENDERS

Proposition 5

Probable savings to be realized with 105 H-10a freight locomotives in the 3rd District (Buffalo to Toledo) equipped with 15,000 gallon tenders and a like number of K-2 and K-3 passenger locomotives equipped with 10,700-gallon tenders, the latter to be used on Line West. No changes in track pans contemplated.

Explanatory Note

Under this Proposition it is proposed to transfer 105 10,700 gallon tenders from H-10a locomotives to K-2 and K-3 locomotives. H-10 locomotives are stoker fired. K-2 and K-3 locomotives are hand fired. Hence, the necessity of equipping the passenger tenders with slope sheet coal pushers to keep the coal within reach of the fireman.

On pages 83-84 in the latter part of the study will be found matter illustrating the slope sheet coal pusher.

Discussion

The 105 10,700-gallon tenders should be used on a like number of main line passenger locomotives on Line West of Buffalo where thay can be employed to the best advantage, as described below:

With 7,500 and 8,000-gallon tenders and under present operating conditions, all through passenger trains must make the following coal and water stops in normal service:

LINE WEST	Trains Involved Annually
(a) Stop at Elyria Coaling Plant for coal and water	11,000
(b) Stop at Graytown, Eastbound, for water	5,500
(c) Stop at Air Line Jct., Westbound, for water	5,500
(d) Stop at Mina Coaling Plant for coal	11,000
Total	33,000
LINE EAST	
(e) Stop for coal at Either St. Johnsville or Wayneport	21,000

(f) The only water trouble experienced on Line East of Buffalo is in covering the distance of 68.6 miles between the track pans at Rome and Seneca River, which is now being overcome without undue difficulty.

The use on Line west of Buffalo of 105 10,700-gallon tenders equipped with slope sheet coal pushers should eliminate 75% (105 tenders would equip 75% of the 140 Line West main line passenger locomotives) of the passenger train stops now being made at Mina Coaling Plant in both directions and at Graytown, Eastbound, and 37½% of the water stops

Air Line Junction, Westbound; resulting in the elimination of approximately 13,687 stops annually. If these tenders were used on the Line East, only 9,744 stops would be eliminated. This indicated from the standpoint of train operation the greater benefit can be realized from the use of the larger tenders on the Line West. The operation with all Line East and Line West main line passenger locomotives equipped with 10,700-gallon tenders will be considered under Propositions 8 and 9.

There are now in operation in the Erie-Cleveland-Franklin Division Pool 5 H-10a's and 35 H-10b's with 15,000-gallon tenders and 105 H-10a's with 10,000-gallon tenders.

The use of 15,000-gallon tenders on the 105 H-10a locomotives should eliminate 9,819 water stops annually in freight service on the Erie Division; 9,533 on the Cleveland Division; 2,340 on the L.E. & P.; 3,694 on the Franklin Division between Youngstown and Ashtabula; and 730 on the J.F. & C.; or a total of 26,116 water stops.

The out-of-pocket expenditure would amount to $1,554,000.00 of which $1,417,000.00 would cover the cost of purchasing and applying 15,000-gallon tenders to 105 H-10a locomotives at $13,500.00 each and $136,000.00 would cover the cost of transferring the 105 10,000-gallon tenders released to passenger service at $500.00 each and equipping same with coal pushers at $800.00 each. The estimated net annual saving should amount to $ 166,425.00, an amount sufficient to return the investment in approximately 7¾ years after allowing 4½% depreciation and 6% interest compounded annually. This is exclusive of the value of 105 7,500 or 8,000-gallon tenders released from K-2's and K-3's which would either be scrapped or held for other service. There would be an

additional saving due to the coal pushers eliminating the necessity of shoveling coal ahead at intermediate terminals within reach of the firemen. Supporting data for this discussion may be found on Page 44.

Proposition 6

Probable savings that should accrue from the use of 15,000-gallon tenders applied to 74 L-1 locomotives now operating on the Toledo and Western Divisions. No changes in track pan facilities contemplated.

Discussion

A number of test trips made in freight service on these two Divisions during April, May, and June 1926 indicates that 15,000-gallon tenders behind the 74 L-1's would save 25,526 water stops annually; resulting in an estimated net annual saving of $150,365.00, exclusive of the benefit to be derived through the operation of these tenders on the Detroit Branch of the Toledo Division and on the main line of the Michigan Division via Adrian and Hillsdale. The salvage value of the tenders so released is not considered. The expenditure for 74 15,000-gallon tenders at $13,500.00 each would amount to $ 999,000.00; however, the estimated saving named above would return the expenditure in about 5½ years after allowing 4½% depreciation and 6% interest compounded annually. Supporting data may be found on Page 52.

Some changes in enginehouse facilities may be necessary before the above can be realized.

Proposition 7

Probable savings that should accrue if the H-5 engines on the Hudson Division were all equipped with 15,000-gallon tenders. No changes in track pan facilities contemplated.

Discussion

The number of locomotives assigned to this Division varies somewhat to suit the volume of business. These locomotives also operate on the River Division. Thwenty-five (25) H-5's have been taken as the average number required for the Hudson Division, 11 of which had 15,000-gallon tenders as of August 15, 1926.

A number of test trips made in fast freight service on this Division during February and March 1926 indicates that 15,000-gallon tenders would save two (2) water stops in each direction. Considering the freight trains (excluding locals) shown on Form OS-1a for the year ending July 31, 1926,- 15,218 water stops annually would probably be eliminated. If the remaining 14 H-5's (56%) were equipped with 15,000-gallon tenders, it is probable that 56% of 15,218 or 8,522 water stops would be eliminated annually. This should result in an estimated net annual saving in operating expense of $65,375.00 and amount sufficient to return the expenditure of $189,000.00 in about 2¾ years. This does not include the scrap credit for the 14 small tenders removed.

Supporting data may be found on Page 60.

Proposition 8

Purchase of 35 - 10,700-gallon tenders in addition to the 105 H-10a tenders referred to in Proposition 5 to complete the installation to the Line West K-2 and K-3 locomotives.

Discussion of this Proposition follows on the next page.

Discussion of Proposition 8

There are 140 K-2's and K-3's assigned to main line passenger service on Line West of Buffalo. If all were equipped with 10,700-gallon tenders and coal pushers, it is estimated the following advantages would accrue therefrom:

(a) Eliminate the coal stop at Mina, both directions. 11,000 trains annually.

(b) Eliminate the water stop at Graytown, Eastbound. 5,500 trains annually.

(c) Eliminate about 50% of present water stops at Air Line Junction, Westbound.--- 2,750 trains annually.

(d) The coal stop at Elyria, both directions, should be eliminated upon the electrification of the Cleveland passenger terminal.

(e) The shoveling ahead of coal within reach of the firemen would probably be eliminated.

Items (a), (b), and (c) amount to approximately 19,250 passenger train stops annually and alludes to through trains only. Thirty-five (35) 10,700-gallon tenders would be needed to complete the installation after the 105, H-10 tenders are used and would probably save 4,813 (25% of 19,250) passenger train stops yearly. The expenditure for 35 tenders at $10,500.00 each would amount to $367,500.00; the interest and depreciation of which would amount to $38,588.00 annually, whereas the 4,813 passenger train stops at $5.00 each would amount to only $24,065.00. This results in an apparent net annual loss of $14,523.00. Even though Proposition 5 justifies the transfer of 10,000-gallon tenders from freight to passenger service, the direct purchase of additional 10,700-gallon tenders to complete the installation on the Line West does not appear advisable at present. Additional data supporting this discussion may be found on Page 64.

Proposition 9.

The direct purchase of 10,700-gallon tenders for 226 K-2 and K-3 passenger locomotives on Line East of Buffalo. No changes contemplated in track pan facilities.

Discussion

It is anticipated that the following benefits would accrue from the use of a complete installation of 10,700-gallon passenger tenders on the Line East:

(a) The necessity of taking water from a fire hose at the Syracuse Station, Westbound would be eliminated.

(b) With the present 7,500 or 8,000-gallon tender, a passenger engine must be occasionally be cut off at Syracuse, Eastbound on account of insufficient water to insure reaching the pan at Rome. The larger tender would eliminate this trouble.

(c) The larger coal capacity and coal pusher that can be furnished with new 10,700-gallon tenders should permit going from Harmon to Buffalo, and vice versa, without stopping for coal, thereby eliminating all of the 21,000 stops now being made at either St. Johnsville or Wayneport with the probable exception of cases of delays due to unusual congestion of traffic during the winter season.

(d) The shoveling ahead of coal within the reach of firemen at Albany, Utica, Syracuse, and Rochester would be eliminated.

(e) The track pans at Schodack and Schenectady may be eliminated without detrimental effect on freight service with a consequent saving of $18,700 annually in maintenance.

There are 238 K-2 and K-3 engines on the Line East, of which 226 are assigned to main line passenger service. The cost of 226 - 10,700-gallon tenders at $10,500.00 each would amount to $2,373,000.00. Allowing no scrap credit for the 226 small tenders displaced, it is estimated that a net annual loss of $125,465.00 would result. This does not include the cost of coal shovelers at intermediate passenger terminals.

Future passenger power will no doubt be of more efficient design and better adapted to main line service. In view of this fact and the apparent loss named in the preceding paragraph, it is believed inadvisable to purchase large tenders for K-2 and the older K-3 passenger locomotives. Additional data supporting this discussion may be found on Page 65.

SECTION -D-

SUPPORTING DATA FOR SECTIONS (B) AND (C)

Proposition 1.

Possible elimination of track pans permitted by present 7,500 or 8,000-gallon passenger tenders and the effect upon freight service using present freight tenders.

Passenger Service

Tests made with the Dynamometer car attached to trains 40, 41, 150, and 151 during August 1925 indicate that by operating upon a close margin for water and considering passenger service only, the pans at Clinton Point, Herkimer, Wende, and Silver Creek can be eliminated. On the following page may be found the information upon which this conclusion is based. This information is taken as being representative of the results of three trips in each direction.

WATER CONSUMPTION IN EASTWARD PASSENGER SERVICE

PASSENGER ENGINES CUT OFF AT BUFFALO K-3 ENGINES 12-CAR TRAIN

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks.
Chicago	Chesterton	3111	4389	2611	
Chesterton	Lydick	2922	4078	2922	
Lydick	Grismore	3872	3128	3872	
Grismore	Stryker	4978	2022	4978	Skipped Corunna
Stryker	Graytown	3580	3420	3580	Stop at water plug.
Graytown	Huron	2672	4328	2672	
Huron	Elyria	1471	5529	1471	Water plug at coal dock.
Elyria	Painesville	4188	2812	4188	
Painesville	Springfield	2807	4193	2807	
Springfield	Westfield	3493	3507	3493	
Westfield	Buffalo	4108	2892	4608	Skipped Silver Creek.
Buffalo	Churchville	4091	3409	3591	New engine at Buffalo. Skipped Wende
Churchville	East Palmyra	2564	4436	2564	
East Palmyra	Seneca River	1500	5500	1500	
Seneca River	Rome	4625	2375	4625	
Rome	Yosts	3171	3929	3171	Skipped Herkimer.
Yosts	Schenectady	2134	4866	2134	
Schenectady	Schodack	1976	5024	1976	
Schodack	Tivoli	1908	5092	1908	
Tivoli	Harmon	4384	2616		Skipped Clinton Point
Total		63555		58671	

The operating margin for water would be somewhat reduced during the winter season.

WATER CONSUMPTION IN WESTWARD PASSENGER SERVICE

PASSENGER ENGINES CUT OFF AT BUFFALO K-3 ENGINE 7,500 GAL. TENDER

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Harmon	Tivoli	4330	3170	3830	Skipped Clinton Point
Tivoli	Schodack	1897	5103	1897	
Schodack	Schenectady	3081	3919	3081	
Schenectady	Yosts	2345	4655	2345	Skipped Herkimer
Yosts	Rome	3952	3048	3952	
Rome	Seneca River	4771	2229	4771	
Seneca River	East Palmyra	1737	5263	1737	
East Palmyra	Churchville	2702	4298	2702	
Churchville	Buffalo	3310	3690	3310	Skipped Wende
Buffalo	Westfield	4699	2301	4699	New engine at Buffalo Skipped Silver Creek
Westfield	Springfield	3925	3075	3925	
Springfield	Painesville	3292	3708	3292	
Painesville	Elyria	3998	3002	3998	Stop at water plug.
Elyria	Huron	1503	5497	1503	
Huron	Air Line Jct.	4199	2801	4199	Stop at water plug.
Air Line Jct.	Stryker	3590	3410	3590	
Stryker	Corunna	3429	3571	3429	
Corunna	Grismore	1674	5326	1674	
Grismore	Lydick	3530	3470	3530	
Lydick	Chesterton	2635	4365	2635	
Chesterton	Chicago	2672	4328		
Total		67271		64099	

FREIGHT SERVICE DATA

Proposition 1

A study of Dispatchers' Train Sheets for a year ending July 31st, 1926 indicates that the removal of the track pans at Clinton Point, Herkimer, and Wende would cause annually 1,095,- 3,815,- and 1,738 freight trains respectively to make an additional stop for water.

A study of Form Os-1b, Freight Train Performance, for the year ending May 31, 1926 shows the following number of fast and slow freight trains as passing over the Silver Creek track pan:

East Fast	-	Erie Division:.....	6,650
East Slow	-	Erie Division.....	1,041
East Slow	-	From Franklin Division.....	1,559
East Slow	-	Total	2,600
West Fast	-	Erie Division.....	3,926
West Slow	-	Erie Division	3,256
West Slow	-	From Franklin Division.....	1,859
West Slow	-	Total	5,115
Grand Total			18,291

The trains noted above are now being handled by 35 H-10b locomotives and 5 H-10a locomotives with 15,000-gallon tenders and 105 H-10a locomotives with 10,000-gallon tenders or, 72.4% 10,000-gallon tenders and 27.6% 15,000-gallon tenders.

In order to better analyze the water requirements and water performance of the Erie Division a number of test trips were made with different types of trains. From a freight operating standpoint the Erie Division is really two divisions, being divided at Wesleyville which is approximately half way between Buffalo and Cleveland. Engine and train crews are changed at Wesleyville and freight locomotives are

coaled and watered. Therefore, any analysis of the water supply situation on this division in freight service must be separated into two parts;- East of Wesleyville and West of Wesleyville. It must also be understood that some of the freight trains on this Division arrive and depart from Gardenville Yard, Buffalo and some arrive and depart from Seneca Yard, Buffalo. The tables appended immediately below represent an analysis of the water requirements based upon the foregoing premise:

ERIE DIVISION — WEST OF WESLEYVILLE

Between	Gallons of Water Consumed			
	East Fast	East Slow	West Fast and Slow	
			From Seneca	From Gardenville
Collinwood & Painesville	5100	5740	3360	3100
Painesville & Springfield	8500	11890	7000	6510
Springfield & Wesleyville	5100	7380	4200	4030
Average consumption	18700	25010	14560	13640
Operating Margin	3000	3000	3000	3000
Average requirements	21700	28010	17560	16640
To be supplied enroute:-				
15,000-Gallon tender	6700	13010	2560	1640
10,000 " "	11700	18010	7560	6640

ERIE DIVISION — EAST OF WESLEYVILLE

Between	Gallons of Water Consumed			
	East Fast	East Slow	West Fast and Slow	
			From Seneca	From Gardenville
Wesleyville & Westfield	5100	5330	4480	3100
Westfield & Silver Creek	3740	3690	3920	4650
Silver Creek & Buffalo	6460	6970	5040	9610
Average consumption	15300	15990	13440	17360
Operating Margin	3000	3000	3000	3000
Average requirements	18300	18990	16440	20360
To be supplied enroute:-				
15,000-gallon Tender	3300	3990	1440	5360
10,000 " "	8300	8990	6440	10360

Applying the firgures shown above to the trains shown on Form OS-1b for the year ending May 31,1926, the following series of tables were made up in an effort to determine the effect upon freight service of removing the pan at Silver Creek.

Erie Division, East Of Wesleyville 10,000-Gal. Tender East Fast Freight
4000 Ton Train H-10 Engine Present Track Pans.

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Wesleyville	Westfield	5100	4900	4600	Fills to 9500 Gal.
Westfield	Silver Creek	3740	5760	3740	" " " "
Silver Creek	Buffalo	6460	3040	----	
Total		15300		8340	

The prededing table indicates that with the use of Silver Creek Pan Eastbound fast freight trains handled by H-10's with 10,000-gallon tenders can go from Wesleyville to Buffalo without making a stop for water.

Erie Division, East of Wesleyville 10,000-Gallon Tender East Fast Freight
4000 Ton Train H-10 Engine Silver Creek Pan Eliminated

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Wesleyville	Westfield	5100	4900	4600	Fills to 9500 Gal.
Westfield	Buffalo	10200	-6700 (Deficit)		Water stop Req'd.
Total		15300		4600	

The above indicates that each Eastward Fast Freight handled by H-10 engine with 10,000-gallon tender must of necessity stop for water between Wesleyville and Buffalo if denied the use of Silver Creek Pan; that is, for the period of a year this would amount to about 72.4% of 6650 trains, or 4815 water stops.

Erie Division, East of Wesleyville Eastward Fast Freight
4000 Ton Train H-10 Engine- 15,000-Gal. Tender Present Track Pans.

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Wesleyville	Westfield	5100	9900	4600	Fills to 14,500 Gal.
Westfield	Silver Creek	3740	10760	3740	" " " "
Silver Creek	Buffalo	6460	8040		No water stop req'd.
Total		15300		8340	

Erie Division, East of Wesleyville Eastward Fast Freight
4000 Ton Train H-10 Engine - 15,000-Gal. Tender. Silver Crk. Pan Removed.

From	To	Gallons Used	In Tender at "TO"	Scooped at "To"	Remarks
Wesleyville	Westfield	5100	9900	4600	Fills to 14,500 Gal.
Westfield	Buffalo	10200	4300	--	No water stop req'd.,
Total		15300		4600	but margin is reduced.

Erie Division, East of Wesleyville 10,000-Gal. Tender. East Slow Freight.
6200 Ton Train H-10 Engine Present Track Pans

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Wesleyville	Westfield	5330	4670	4930	Fills to 9500 Gal.
Westfield	Silver Creek	3690	5810	3690	" " " "
Silver Creek	Buffalo	6970	2530	--	Rather close margin
Total		15990		8620	

Erie Division, East of Wesleyville 10,000-Gal. Tender East Slow Freight
6200 Ton Train H-10 Engine Silver Creek Pan Eliminated

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Wesleyville	Westfield	5330	4670	4830	Fills to 9500 Gal.
Westfield	Buffalo	10660	-1160 (Deficit)		Water stop req'd.
Total		15990		4830	

Erie Division, East of Wesleyville 15,000-Gal. Tender East Slow Freight
6200 Ton Train H-10 Engine Present Track Pans

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks.
Wesleyville	Westfield	5330	9670	4830	Fills to 14,500 Gal.
Westfield	Silver Creek	3690	10810	3690	" " " "
Silver Creek	Buffalo	6970	7530	--	No water stop req'd.
Total		15990		8520	

Erie Division, East of Wesleyville 15,000-Gal. Tender East Slow Freight
6200-Ton Train H-10 Engine Silver Creek Pan Eliminated

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Wesleyville	Westfield	5330	9670	4930	Fills to 14,500 Gal.
Westfield	Buffalo	10660	3840	--	No water stop req'd.
Total		15990		4930	

Erie Division, East of Wesleyville Westward Fast & Slow Freight
2200-Ton Train H-10 Engine- 10,000-Gal.Tender Present Track Pans.

Train from Seneca From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Buffalo	Silver Creek	5040	4960	4540	Fills to 9500 Gal.
Silver Creek	Westfield	3920	5580	3920	" " " "
Westfield	Wesleyville	4480	4020	---	No water stop req'd.
Total		13440		8460	

Erie Division, East of Wesleyville Westward Fast & Slow Freight
2200-Ton Train H-10 Engine- 10,000-Gal. Tender. Pan at Silver Ck. Removed.

Train from Seneca From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Buffalo	Westfield	8960	1040	5000	Margin too small.
Westfield	Wesleyville	4480	1560	---	" " "
Total		13440		5000	

The two tables immediately above indicate that the removal of the pan at Silver Creek would cause all Westward Fast & Slow Freights from

Seneca handled by H-10 engines equipped with 10,000-gallon tenders to stop for water between Buffalo and Westfield. This amounts to 72.4% of (9041 - 3271), or 4177 water stops annually.

Erie Division, East of Wesleyville Westward Fast & Slow Freight
2200-Ton Train H-10 Engine- 15,000-Gal. Tender. Present Track Pans

Train from Seneca		Gallons	In Tender	Scooped	
From	To	Used	at "To"	at "To"	Remarks.
Buffalo	Silver Creek	5040	9960	4540	Fills to 14,500 Gal.
Silver Creek	Westfield	3920	10580	3920	" " " "
Westfield	Wesleyville	4480	10020	--	No water stop req'd.
Total		13440		8460	

Erie Division, East of Wesleyville Westward Fast & Slow Freight
2200-Ton Train H-10 Engine - 15,000-Gal. Tender Pan at Silver Ck. Removed

Train from Seneca		Gallons	In Tender	Scooped	
From	To	Used	at "To"	at "To"	Remarks
Buffalo	Westfield	8960	6040	5000	Fills to 11,040 Gal.
Westfield	Wesleyville	4480	6520	---	No water stop req'd.
Total		13440		5000	

Erie Division, East of Wesleyville Westward Fast & Slow Freight
2200-Ton Train H-10 Engine- 10,000-Gal. Tender Present Track Pans.

Train from Gardenville		Gallons	In Tender	Scooped	
From	To	Used	at "To"	at "To"	Remarks
Gardenville	Angola	7220	2780	7220	Stop at water plug.
Angola	Silver Creek	2390	7610	1890	Fills to 9500 Gal.
Silver Creek	Westfield	4650	4850	4650	" " " "
Westfield	Wesleyville	3100	6400	--	
Total		17360		13760	

Erie Division, East of Wesleyville. Westward Fast & Slow Freight
2200-Ton Train H-10 Engine -10000-Gal. Tender Pan at Silver Ck. Removed.

Train from Gardenville		Gallons	In Tender	Scooped	
From	To	Used	at "To"	at "To"	Remarks
Gardenville	Angola	7220	2780	7220	Stop at water plug
Angola	Westfield	7040	2960	5000	Margin too small
Westfield	Wesleyville	3100	4860	--	Two water stops req'd.
Total		17360		12220	

Erie Division, East of Wesleyville Westward Fast & Slow Freight
2200-Ton Train H-10 Engine - 15,000-Gal. Tender. Present Track Pans.

Train from Gardenville		Gallons	In Tender	Scooped	
From	To	Used	at "To"	at "To"	Remarks
Gardenville	Silver Creek	9610	5390	5000	Fills to 10,390 Gal.
Silver Creek	Westfield	4650	5740	5000	" " 10,740 "
Westfield	Wesleyville	3100	7640	---	No water stop req'd.
Total		17,360		10000	

Erie Division, East of Wesleyville Westward Fast & Slow Freight 2200-Ton Train H-10 Engine - 15,000-Gal. Tender Pan at Silver Ck. Removed.					
Train from Gardenville		Gallons	In Tender	Scooped	
From	To	Used	at "To"	at "To"	Remarks
Gardenville	Westfield	14260	740	5000	Fills to 5740 Gal.
Westfield	Wesleyville	3100	2640	--	Margin too small in
Total		17360		5000	both cases.

The four tables immediately preceding indicate that the removal of the track pan at Silver Creek would cause Westward Fast & Slow Freights out of Gardenville to make an extra stop per trip, or 3272 stops annually. From June 1st, 1925 to May 31, 1926 there were 224 Fast Freights and 3,048 Slow Freights dispatched Westward from Gardenville Yard. (Supt. Brogan's letter of July, 1, 1926, file 40.4, Office of Supt. Fuel and Locomotive Performance, Utica, N.Y.)

SUMMARY OF ADDITIONAL WATER STOPS NECESSARY IN FAST AND SLOW FREIGHT SERVICE ON ERIE DIVISION EAST OF WESLEYVILLE IF DENIED THE USE OF THE TRACK PAN AT SILVER CREEK. (PRESENT FREIGHT TENDERS)

Class Of Service	Tender Cap'y Gals.	Water Stops Required		Additional Stops	
		With Silver Ck. Pan	Without Silver Ck. Pan	Per Trip	Annually
East Fast	10,000	0	1	1	0.724 x 6650 = 4815
	15,000	0	0	0	0
East Slow	10,000	1	1	0	0
	15,000	0	0	0	0
West Fast and Slow From Seneca	10,000	0	1	1	0.724 x (9041-3272) = 4177
	15,000	0	0	0	0
West Fast and Slow From G'ville	10,000	1	2	1	0.724 x 3272 = 2369
	15,000	0	1	1	0.2760x 3272 = 903
TOTAL					12,264

A financial statement covering the removal of the pans under this Proposition follows on the next page:-

FINANCIAL STATEMENT ---- PROPOSITION 1.

Removal of track pans permitted by present passenger tenders (7,500-gallon).
Passenger engines operated - Harmon-Buffalo and Buffalo-Chicago

ITEM	DEBIT	CREDIT
Removal of Clinton Point Pan (Cost Figures based upon similar figures for Tivoli Pan for 1923-24-25)		
Gross Cost of maintenance and operation		$ 26,450.00
Cost of fuel and supplies for increased load at other plants	$ 7,756.00	
Fixed charges (10% of investment)	$ 8,000.00	
Cost of 1,095 freight water stops yearly	$ 10,950.00	
Total	$ 26,706.00	$ 26,450.00
	$ 26,450.00	
Estimated Net Annual LOSS	$ 256.00	
Removal of Herkimer Track Pan (Cost Figures from J.V.Neubert - 1923-24-25)		
Gross cost of maintenance and operation		$ 33,771.00
Cost of fuel and supplies for increased load at other plants	$ 7,804.00	
Fixed charges (10% of investment)	$ 8,000.00	
Cost of 3,815 freight water stops yearly	$ 38,150.00	
Total	$ 53,954.00	$ 33,771.00
	$ 33,771.00	
Estimated Net Annual LOSS	$ 20,183.00	
Removal of Wende Track Pan (Cost figures based upon similar data for E. Palmyra 1923-24-25)		
Gross cost of maintenance and operation		$ 27,978.00
Cost of fuel and supplies for increased load at other plants	$ 3,195.00	
Fixed Charges (10% of investment)	$ 8,933.00	
Cost of 1,738 freight water stops yearly	$ 17,380.00	
Total	$ 29,508.00	$ 27,978.00
	$ 27,978.00	
Estimated Net Annual LOSS	$ 1,530.00	

FINANCIAL STATEMENT ---- PROPOSITION 1

ITEM	DEBIT	CREDIT
Removal of Silver Creek Pan (Cost figures based on Painesville Pan for 1925)		
Gross cost of operation and maintenance		$ 55,909.00
Fixed charges (10% of investment).....	$ 14,560.00	
Cost of water purchased (#).....	$ 23,592.00	
Cost of 12,264 freight water stops yearly...	$122,640.00	
Total.....	$160,792.00	$ 55,909.00
	$ 55,909.00	
Estimated Net Annual LOSS.....	$104,883.00	

(#) The water now being purchased at Silver Creek at $0.045 per 1000 gallons would need to be purchased at Angola and Dunkirk and pumped at Westfield at a cost of $0.094, $0.068, and $0.052 per 1000 gallons respectively. Hence the removal of Silver Creek Track pan would not decrease the total cost of water purchased on the Erie Division.

SUPPORTING DATA ---- PROPOSITION 2

Possible elimination of track pans permitted by 10,700-gallon tenders on all locomotives in main line passenger service and the effect thereof upon freight service with present freight tenders; the cost and benefit, other than track pan elimination, of the 10,700-gallon tenders will be considered under Propositions 8 and 9.

Water Performance - Passenger Service

The following water consumption tables covering the use of 10,700-gallon tenders in passenger service were developed from Dynamometer Car data secured in August of 1926.

Water Consumption in Eastward Passenger Service. 10,700-Gallon Tenders
K-3 Engine 12-Car Train. Engines Cut Off at Buffalo

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks.
Chicago	Lydick	6033	4167	5300	Skipped Chesterton
Lydick	Corunna	6039	3428	5300	" Grismore
Corunna	Stryker	2811	5917	4283	
Stryker	Huron	6252	3948	5700	
Huron	Painesville	5659	3989	5300	
Painesville	Westfield	6300	2989	5300	Skipped Springfield
Westfield	Buffalo	4108	4181	6019	" Silver Creek
Buffalo	Churchville	4091	6109	4091	" Wende
Churchville	Seneca River	4064	6136	4064	" East Palmyra
Seneca River	Rome	4625	5575	4625	
Rome	Yosts	3171	7029	3171	Skipped Herkimer
Yosts	Tivoli	6018	4182	4950	" Schodack,
Tivoli	Harmon	4384	4748	---	Schenectady and
Total		63555	[illegible]	58103	Clinton Point.

Note: Engine leaves Buffalo with a full tank of water.

Water Consumption in Westward Passenger Service 10,700-Gallon Tenders.
K-3 Engine 12-Car Train. Engines Cut Off at Buffalo.

From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Harmon	Tivoli	4330	5870	4330	Skipped Clinton Point.
Tivoli	Yosts	7328	2877	3850	" Scodack & Sch'dy.
Yosts	Rome	3952	2775	5500	Skipped Herkimer
Rome	Seneca River	4771	3504	4950	
Seneca River	Churchville	4439	4015	4950	Skipped East Palmyra
Churchville	Buffalo	3310	5655	4545	" Wende
Buffalo	Westfield	4699	5501	4699	" Silver Creek
Westfield	Springfield	3925	6275	3925	
Springfield	Painesville	3292	6908	3292	
Painesville	Huron	5501	4699	5501	
Huron	Stryker	7789	2411	5300	
Stryker	Corunna	3429	4283	5300	
Corunna	Lydick	5204	4378	5300	Skipped Grismore
Lydick	Chicago	5307	4371	--	" Chesterton
Total		67271		61442	

Note: Engine leaves Buffalo with a full tank of water.

Water Performance --- Freight Service

The additional freight water stops necessary if the pans at Clinton Point, Herkimer, Wende, and Silver Creek were eliminated have not changed from the number shown un der Proposition 1; that is, - 1,095; 3,815; 1,738; and 12,264 respectively. The pans at Schodack and Schenectady do not affect freight service. A study of Syracuse Division Train Sheets for the year ending July 31, 1926 indicates that the removal of the pan

at East Palmyra would bring about 3,267 additional freight service water stops annually.

Toledo Division Freight Service

To determine the effect upon freight service of removing the pan at Grismore,- a number of test trips were made during April, May, and June 1926 on this Division. The results of these tests suggest the following water consumption between various points.

	Gallons of Water Consumed		
Between	West Fast	West Slow	East Fast And Slow
Elkhart and Grismore Pan	5220	4320	6500
Grismore Pan and Corunna Pan	4640	5040	5250
Corunna Pan and Mina Coal Dock	5220	7560	3500
Mina Coal Dock and Stryker Pan	4060	6120	2500
Stryker Pan and Delta Water Plug	4350	5400	--
Stryker Pan and Swanton Water Plug	----	----	4500
Delta Water Plug and Toledo	5510	7560	--
Swanton Water Plug and Toledo	----	----	2750
Total consumption	29000	36000	25000
Operating margin	3000	3000	3000
Average total requirements	32000	39000	28000
Capacity of Tender	7820	7820	7820
To be supplied enroute	24180	31180	20180

The following series of tables are worked out with a view of determining the additional water stops necessary if freight trains were denied the use of the track pan at Grismore on the Toledo Division.

Toledo Division 3500-Ton Train		7,820-Gallon Tenders L-1 Engine.		Eastward Fast & Slow Frt. Present Track Pans.	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks.
Elkhart	Grismore	6500	1320	5000	Margin too small
Grismore	Corunna	5250	1070	5000	" " "
Corunna	Mina	3500	2570	5250	Stop at water plug.
Mina	Stryker	2500	5320	2000	Fills to 7,320 Gal.
Stryker	Swanton	4500	2820	5000	Stop at water plug.
Swanton	Toledo	2750	5070	--	
Total		25000		22250	

It will be noted from the above that Eastward freight trains must stop at least twice for water in addition to scooping at all pans. The margin between Elkhart and Grismore and between Grismore and Corunna is too small for every day operation, but the enginemen on this and the

Western Divisions work their water on closer margins; therefore we are making a concession on this Division with regard to the established 3,000-gallon operating margin.

Toledo Division 3400-Ton Train		7,820-Gallon Tender L-1 Engine		Westward Fast Freight Present Track Pans.	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Delta	5510	2310	5510	Stop at water plug.
Delta	Stryker	4350	3470	3850	Fills to 7,320 Gal.
Stryker	Mina	4060	3260	4560	Stop at water plug.
Mina	Corunna	5220	2600	4720	Fills to 7,320 Gal.
Corunna	Grismore	4640	2680	4640	" " " "
Grismore	Elkhart	5220	2100	--	Rather small margin
Total		29000		23280	

Toledo Division 5000-Ton Train		7,820-Gallon Tender L-1 Engine		Westward Slow Freight Present Track Pans.	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Delta	7560	260	7560	Margin too small.
Delta	Stryker	5400	2420	4900	
Stryker	Mina	6120	1200	6620	Margin too small.
Mina	Corunna	7560	260	5000	" " "
Corunna	Grismore	5040	220	5000	" " "
Grismore	Elkhart	4320	900	--	
Total		36000		29080	

It will be noted that the water performance outlined immediately above is not very satisfactory for Westward Slow Freight operation, hence the table below is given as an example of a more satisfactory performance.

Toledo Division 5,000-Ton Train		7,820-Gallon Tender 1-1 Engine		Westward Slow Freight Present Track Pans.	
From To	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Swanton	5500	2320	5500	Stop at water plug.
Swanton	Wauseon	3900	3920	3900	" " " "
Wauseon	Stryker	3560	4260	3060	Fills to 7,320 Gal.
Stryker	Mina	6120	1200	6620	Stop at water plug.
Mina	Waterloo	5460	2360	5460	" " " "
Waterloo	Corunna	2100	5760	1600	Fills to 7,320 Gal.
Corunna	Grismore	5040	2280	5000	" " 7,280 " .
Grismore	Elkhart	4320	2960	--	
Total		36000		31140	

This indicates that FOUR water stops are now nesessary in Westward Slow Freight service on the Toledo Division in addition to scooping at all three track pan stations.

The preceding series of water consumption tables proves that, if denied the use of Grismore track pan, all freight trains must make a water stop at that location. Considering the freight trains (excluding locals) shown on Form OS-1b for a year ending May 31, 1926, the number of stops thus brought would amount to 6,979 yearly.

Western Division Freight Service

A number of test trips made in freight service on the Western Division in June 1926 suggests the following water consumption figures bewteen various points:

Gallons of Water Consumed		
Between	East Fast & Slow	West Fast & Slow
Englewood and Chesterton Pan	5550	7030
Chesterton Pan and Lydick Pan	5550	6660
Lydick Pan and Elkhart	3900	4810
Total consumption	15000	18500
Margin for safe operation	3000	3000
Total requirements	18000	21500
Capacity of tender	7820	7820
To be supplied enroute	10180	13680

The following series of performance tables are worked out with the view of determining the effect upon freight service of the removal of the track pan at Chesterton:

Western Division 3300-Ton Train		7,820-Gallon Tender L-1 Engine		Eastward Fast & Slow Freight. Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Englewood	Chesterton	5550	2270	5000	Rather small margin
Chesterton	Lydick	5550	1720	5000	" " "
Lydick	Elkhart	3900	2820	--	
Total		15000		10000	

It is noted from the above that in most cases a water stop would be made somewhere before reaching Lydick in addition to scooping at Chesterton. It is immaterial where the stop is made, therefore, it will be assumed at Pinola Coal Dock. In actual service many of the stops are made at Pine because the engineman wants to be assured of a full tank leaving Chesterton. In most cases the stop at Pine forestalls the stop

at Pinola.

Western Division 3,300-Ton Train		7,820-Gallon Tender L-1 Engine		Eastward Fast & Slow Frt. Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Englewood	Chesterton	5550	2270	5000	Rather small margin
Chesterton	Pinola	2500	4770	3050	Stop at water plug.
Pinola	Lydick	3050	4770	2550	Fills to 7320 Gal.
Lydick	Elkhart	3900	3420	----	
Total		15000		10600	

Western Division 3,500-Ton Train		7,820-Gallon Tender L-1 Engine		Westward Fast & Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Elkhart	Lydick	4810	3010	4310	Fills to 7,320 Gal.
Lydick	Pinola	5000	2320	5500	Stop at water plug.
Pinola	Chesterton	1660	6160	1160	Fills to 7,320 Gal.
Chesterton	Pine	3700	3620	4200	Stop at water plug.
Pine	Englewood	3330	4490	--	
Total		18500		15170	

It will be noted from the above that all freight trains denied the use of the track pan at Chesterton must stop for water at that location. This amounts to 9,071 freight service water stops annually.(Form OS-1b for a year ending May 31, 1926.).

FINANCIAL STATEMENT -- PROPOSITION 2

The financial statements for the elimination of the pans at Clinton Point, Herkimer, Wende, and Silver Creek have not changed from Proposition (1).

Freight service does not make use of the pans at Schodack and Schenectady and therefore the saving in operation at those stations would be net, provided all passenger engines were equipped with 10,700-gallon tenders. Assuming that the water plugs at Schodack can be eliminated, the removal of the pan brings about an annual saving of $10,700.00., which is based upon a three-year average of the cost of operating and maintaining

(less cost of fuel and fixed charges) of the pan at Tivoli.

The saving realized through the elimination of the pan at Schenectady would not exceed $8,000.00 annually (based upon cost figures for pan at Yosts), distributed as follows:-

Excessive track maintenance	$3,000.00
Repairs to track pans, pipe lines, etc	$3,000.00
Picking ice, handling coal, ashes	$2,000.00
Total	$8,000.00

Elimination of the Pan at East Palmyra

Assuming that the pumping plant and water pulgs at East Palmyra can be eliminated, the finances involved in connection with the removal of the pan are as follows:-

Debit 3,267 freight service water stops at $10.00 each	$32,670.00
Credit cost of operation and maintenance of East Palmyra Pan less fuel and fixed charges (Average of 1923-24-25)	$15,850.00
Estimated Net Annual LOSS	$16,820.00

Elimination of the Pan at Grismore

	Debit	Credit
Repairs to pumping plant, pipe lines, etc		$ 7,138.00
Excessive track maintenance		$ 1,800.00
Handling coal, ashes, picking ice		$ 571.00
Cost of 6,979 freight service water stops	$ 69,790.00	
Total	$ 69,790.00	$ 9,509.00
	$ 9,509.00	
Estimated Net Annual LOSS	$ 60,281.00	

Elimination of the Pan at Chesterton

	Debit	Credit
Assuming same cost figures as for the removal of the pan at Grismore		$ 9,509.00
Cost of 9,071 freight service water stops annually at $10.00 each	$90,710.00	
Total	$90,710.00	$ 9,509.00
	$ 9,509.00	
Estimated Net Annual LOSS	$81,201.00	

Due to infrequency of water stations on the Line West, it does not seem advisable to remove the pumping plants and water plugs at Grismore and Chesterton.

SUPPORTING DATA -- PROPOSITION (3)

Possible elimination of track pans permitted by 10,700-gallon passenger tenders and the effect upon freight service with all freight engines equipped with 15,000-gallon tenders.

Passenger Service

The water performance in passenger service under this Proposition is the same as shown on Page and suggests the elimination of the pans at Clinton Point, Schodack, Schenectady, Herkimer, East Palmyra, Wende, Silver Creek, Grismore, and Chesterton.

Freight Service

The only pans named in the preceding paragraph that would be affected by future installation of 15,000-gallon freight tenders are at Clinton Point, Silver Creek, Grismore, and Chesterton.

Clinton Point - Hudson Division

A study of the Train Sheets for a period of a year indicates that if 15,000-gallon tenders were used on the Hudson Division, the removal of the track pan at Clinton Point would probably cause 3,970 additional freight service water stops annually.

Silver Creek -- Erie Division.

From the table on Page 28 it can be seen that with 15,000-gallon tenders, 3272 westward freight trains dispatched from Gardenville would have to make a water stop each trip if they were denied the use of the pan at Silver Creek.

Grismore -- Toledo Division

The following water performance tables will show the effect of the removal of the track pan at Grismore if all freight motive power on this Division were equipped with 15,000-gallon tenders.

Toledo Division 3500-Ton Train		15,000-Gallon Tender L-1 Engine		East Fast & Slow Freight Present Track Pans.	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Elkhart	Grismore	6500	8500	5000	
Grismore	Corunna	5250	8250	5000	
Corunna	Stryker	6000	7250	5000	
Stryker	Toledo	7250	5000	----	No water stops req'd.
Total		25000		15000	

Toledo Division 3500-Ton Train		15,000-Gallon Tender L-1 Engine		East Fast & Slow Freight Grismore Pan Removed	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Elkhart	Corunna	11750	3250	5000	Fills to 8250 Gal.
Corunna	Stryker	6000	2250	5000	" " 7250 "
Stryker	Toledo	7250	0	----	One water stop req'd
Total		25000		10000	

The above analysis reveals that the removal of Grismore Track Pan would result in having all Eastward freight trains make an additional stop for water even though the freight motive power was equipped with 15,000-gallon tenders. This would amount to 3964 water stops annually.

Toledo Division 3500-Ton Train		15,000-Gallon Tender L-1 Engine		Westward Fast Freight Present Track Pans	
From	To	Gallons Used	In Tender at"To"	Scooped at "To"	Remarks
Toledo	Stryker	9860	5140	5000	
Stryker	Corunna	9280	860	5000	Margin too small
Corunna	Grismore	4640	1220	5000	" " "
Grismore	Elkhart	5220	1000	---	One Water stop req'd.
Total		29000		15000	

Toledo Division 3500-Ton Train		15,000-Gallon Tender L-1 Engine			Westward Fast Freight Grismore Pan Removed
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Stryker	9860	5140	5000	
Stryker	Corunna	9280	860	5000	Margin too small
Corunna	Elkhart	9860	-4000 (Deficit)		One water stop req'd.
		29000		10000	

The above analysis indicates that all Westward Fast Freights must stop for water between Stryker and Corunna regardless of the pan at Grismore.

Toledo Division 5000-Ton Train		15,000-Gallon Tender L-1 Engine			Westward Slow Freight Present Track Pans.
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Stryker	12960	2040	5000	
Stryker	Corunna	13680	-6640 Def.	5000	Unsatisfactory, see
Corunna	Grismore	5040	~~6680~~ "	5000	table below
Grismore	Elkhart	4320	-6000 "	---	
Total		36000		15000	

Toledo Division 5000-Ton Train		15,000-Gallon Tender L-1 Engine			Westward Slow Freight Present Track Pans.
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Stryker	12960	2040	5000	
Stryker	Mina	6120	920	14080	Stop at water plug
Mina	Corunna	7560	7440	5000	
Corunna	Grismore	5040	7400	5000	
Grismore	Elkhart	4320	8080	---	
Total		36000		29080	

Toledo Division 5000-Ton Train		15,000-Gallon Tender L-1 Engine			Westward Slow Freight Grismore Pan Removed
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Stryker	12960	2040	5000	Unsatisfactory, see
Stryker	Corunna	13680	-6640 Def.	5000	next table.
Corunna	Elkhart	9360	-11000 "	---	
Total		36000		10000	

Toledo Division 5000-Ton Train		15,000-Gallon Tender L-1 Engine			Westward Slow Freight Grismore Pan Removed
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Stryker	12960	2040	5000	
Stryker	Mina	6120	920	14080	Stop at water plug.
Mina	Corunna	7560	7440	5000	
Corunna	Elkhart	9360	3080	----	
Total		36000		24080	

The four tables immediately preceding indicate that with a full installation of 15,000-gallon tenders on freight engines, the removal of the pan at Grismore would not seriously affect Westward Slow Freight service. It would, however, decrease the operating margin and of course would have some undesirable effect.

Chesterton -- Western Division

Using the water consumption figures shown on Page 34 the following series of tables have been worked out to show the effect on freight service with 15,000-gallon tenders of the removal of the pan at Chesterton.

Western Division 3200-Ton Train		15,000-Gallon Tender L-1 Engine		East Fast & Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Englewood	Chesterton	5550	9450	5000	
Chesterton	Lydick	5550	8900	5000	
Lydick	Elkhart	3900	10000	--	No water stops req'd.
Total		15000		10000	

Western Division 3200-Ton Train		15,000-Gallon Tender L-1 Engine		East Fast & Slow Freight Chesterton Pan Removed	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Englewood	Lydick	11100	3900	5000	
Lydick	Elkhart	3900	5000	--	No water stops req'd.
Total		15000		5000	

It would appear from the above that Eastbound freight service with 15,000-gallon tenders would permit the removal of the pan at Chesterton. In reality, the removal of the pan would decrease the operating margin and in doing so would obviously affect this class of service.

Western Division 3500-Ton Train		15,000-Gallon Tender L-1 Engine		West Fast & Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Elkhart	Lydick	4810	10190	5000	
Lydick	Chesterton	6660	7840	5000	
Chesterton	Englewood	7030	5810	--	No water stops req'd.
Total		18500		10000	

Western Division 3500-Ton Train		15,000-Gallon Tender L-1 Engine		West Fast & Slow Freight Chesterton Pan Removed	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Elkhart	Lydick	4810	10190	4310	Fills to 14,500 Gal.
Lydick	Englewood	13690	810	--	On water stop req'd
Total		18500		4310	

It would appear, therefore, that with the use of 15,000-gallon tenders in freight service on the Western Division, the removal of the Chesterton track pan would cause each Westward freight to make an additional stop for water. In a year this would amount to 4189 stops annually. (Form OS-1b, excluding locals, for the year ending May 31, 1926.).

FINANCIAL STATEMENT -- PROPOSITION (3)

Possible elimination of pans permitted by 10,700-gallon passenger tenders; freight tenders assumed to be of 15,000 gallons capacity.

The only pans enumerated in this Proposition affected by future installation of 15,000-gallon tenders in freight service are the pans at Clinton Point, Silver Creek, Grismore, and Chesterton. The losses incident to the removal of the other five pans are the same as shown under Propositions (1) and (2).

Elimination of the Track Pan at Clinton Point

Item	Debit	Credit
Gross cost of operation and maintenance (Based upon similar figures for Tivoli)		$26450.00
Cost of fuel & supplies for increased load at other plants	$ 7756.00	
Fixed charges (10% of investment)	$ 8000.00	
Cost of stopping 3970 freight trains at $10.00 each	$39700.00	
Total	$55456.00	$26450.00
	$26450.00	
Estimated Annual LOSS	$29006.00	

Elimination of the Track Pan at Silver Creek

Item	Debit	Credit
Gross Cost of Operation and maintenance Based upon similar figures for Painesville.....		$ 55,909.00
Fixed charges (10% of investment).....	$ 14,560.00	
Cost of water purchased.....	$ 23,592.00	
Cost of making 3271 additional freight stops at $10.00 each.....	$ 32,710.00	
Total.....	$ 70,862.00	$ 55,909.00
	$ 55,909.00	
Estimated Net Annual LOSS.....	$ 14,553.00	

Elimination of the Track Pan at Grismore

Item	Debit	Credit
Credit removal of pan, maintenance and operation Proposition (2), Page		$ 9,509.00
Cost of making 3964 additional freight water stops at $10.00 each.....	$ 39,640.00	
Total.....	$ 39,640.00	$ 9,509.00
	$ 9,509.00	
Estimated Net Annual LOSS.....	$ 30,131.00	

Elimination of the Track Pan at Chesterton

Item	Debit	Credit
Credit saving in operation and maintenance by the removal of the pan (Proposition 2).....		$ 9,509.00
Cost of making 4189 additional freight water stops at $10.00 each.....	$ 41,890.00	
Total.....	$ 41,890.00	$ 9,509.00
	$ 9,509.00	
Estimated Net Annual LOSS.....	$ 32,381.00	

SUPPORTIN DATA -- PROPOSITION (4)

Possible elimination of track pans without detrimental effect upon freight service and with the use of 10,700-gallon passenger tenders.

Freight service does not use the track pans at Schodack and Schenectady. Results found with the Dynamometer car indicate that if all passenger locomotives operating over the main line of the Line East of Buffalo were equipped with 10,700-gallon tenders, these two pans could be eliminated. Not considering the investment in the larger tenders, the saving in operation and maintenance at these two stations would be net. The water performance of the 10,700-gallon tenders in passenger service may be found on Page 31.

Assuming that the water plug and pumping plant at Schodack can be eliminated, the removal of the track pan station should result in an annual saving of approximately $ 10,700.00 (Based upon the yearly average of the costs at Tivoli less fuel and fixed charges).

The saving to be realized through the removal of the track pan at Schenectady would not exceed $ 8,000.00 yearly due to the fact that the enginehouse and yard would require the maintenance of the pumping plant at that point. The apparent $ 8,000. 00 saving is based upon the approximate cost at Yosts and would be divided as follows:

Repairs to pans and pipe lines in connection with the pans only	$ 3,000.00
Excessive track maintenance	$ 3,000.00
Picking ice, etc.	$ 2,000.00
Total	$ 8,000.00

SUPPORTING DATA, PROPOSITION (5)

Probable savings to be realized with 105 H-10A's in the Third District equipped with 15,000 gallon tenders and a like number of K-2 and K-3 locomotives equipped with 10,700 gallon tenders, the latter to be used on Line West; (present track pans).

PASSENGER SERVICE:

The water performance tables on page 31 indicate that with a 10,700 gallon tender, an average 12 car passenger train should go Westbound from the track pan at Huron to the pan at Stryker with a margin of approximately 2400 gallons which is 600 gallons less than the desired 3000 gallon operating margin. It is believed that approximately 50% of these Westbound trains can eliminate the water stop at Air Line Junction, amounting to some 2,750 trains annually. In addition, the following stops should be saved:

(a) Coal stop at Mina, both directions, approximately 11,000 trains annually

(b) Water " " Graytown Eastbound " 5,500 " "

FREIGHT SERVICE:

Franklin Division

A number of test trips made on this division during April 1926 under the auspices of the Division Superintendent indicates that 15,000 gallon tenders would save at least one water stop between Youngstown and Ashtabula. Considering freight trains, excluding locals, shown on Form 0S1b for a year ending May 31, 1926, the 105 tenders would probably save 72.4% of 5103, or 3694 water stops annually.

J. F. & C. Branch of Franklin Division

As of November 15, 1926, there were two H-10A's operating daily between Ashtabula and Oil City. A number of test trips made by the Road Foreman of Engines of this territory reveals that 15,000 gallon tenders would save one

water stop per trip. Two stops daily for a period of a year would amount to 730 water stops.

Cleveland Division, L. E. & P. Branch

The following is the result of a study made on the L. E. & P. by the Chief Train Dispatcher:

During the first fifteen days of May 1925, 83 freight trains handled by locomotives with small tenders made 171 stops for water, an average of 2.05 stops per train. During the same period of 1926, 92 freight trains handled by engines with 15,000 gallon tenders made 97 stops for water, an average of 1.05 water stops per train. The larger tenders seem to be responsible for saving one water stop per train. At this rate, the 105 tenders would save 72.4% of 3231, or 2340 water stops annually on this Branch.

Cleveland Division, Main Line

A number of trips made in freight service on this Division in May, 1926 indicates the following water comsumption figures between various points:

BETWEEN	FAST AND SLOW FREIGHT	
	EASTBOUND	WESTBOUND
Air Line Junction and Graytown	4010	4000
Graytown " Danbury plug	2720	3490
Dunbury " Sandusky	2130	1150
Sandusky " Huron pan	1370	1520
Huron pan " Elyria	3700	4140
Elyria " Rockport yard	2320	2330
Rockport Yard " Collinwood	2750	5370
Average Total Consumption.....	19000	22000
Operating margin.....	3000	3000
Average Total requirements.....	22000	25000
Capacity of tender.....	15000	15000
To be supplied en route, 15000 gal. tank	7000	10000
" " " " " 10000 " "	12000	15000

The tables on the following page showing water performance on this Division were worked out in an endeavor to determine the water stops to be saved from the use of 15,000 gallon tenders on 105 H-10A's:

Cleveland Division 2400 Ton Train		10,000 gallon tenders H-10 Engine		East Fast and Slow Freight Present 2400 ft. pan at Huron	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Huron	10230	230 Deficit	6000	
Huron	Collinwood	8770	3000	-	
Total		19000		6000	

The above indicates that two stops are necessary, one between Toledo and Huron and another between Huron and Collinwood. The following table will show such an arrangement:

Cleveland Division 2400 Ton Train		10,000bgallon tenders H-10 Engine		East Fast and Slow Freight Present 2400 ft. pan at Huron	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Danbury	6730	3270	6730	Stop at water plug
Danbury	Huron	3500	6500	3000	Filled to 9500 gals.
Huron	Elyria	3700	5800	4200	Stop at water plug
Elyria	Collinwood	5070	4930	*	
Total		19000		13930	

Cleveland Division 2400 Ton Train		15,000 gallon tenders H-10 Engine		East Fast and Slow Freight Present 2400 ft. pan at Huron	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Huron	10230	4770	6000	
Huron	Collinwood	8770	2000	-	Margin too small
Total		n19000		6000	

The preceding table indicates that the locomotives with 15,000 gallon tenders must stop some place for water because the pan at Huron is not long enough to secure sufficient water to go to Collinwood. It is immaterial where the stop is made. It should not be necessary to take coal with a 15,000 gallon tender, so the water stop is assumed to be at Danbury.

Cleveland Division 2400 Ton Train		15,000 gallon tenders H-10 Engine		East Fast and Slow Freight Present 2400 ft. pan at Huron	
From	To	Gallons Used	In Tender at "TO"	Scooped at "To"	Remarks
Toledo	Danbury	6730	8270	6730	Stop at water plug
Danbury	Huron	3500	11500	3000	Filled to 14,500 gals.
Huron	Collinwood	8770	5730	-	
Total		19000		9730	

The preceding four water performance tables indicate that 15,000 gallon tenders would save one water stop per trip with each Eastbound freight train on the main line of the Cleveland Division. For 105 tenders, this would amount to approximately 72.4% of 4777, or 3459 water stops saved annually.

Cleveland Division 3500 Ton Train		10,000 gallon tenders H-10 Engine		West Fast and Slow Freight Present 2400 ft. pan at Huron	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Collinwood	Huron	11840	1840 Deficit	6000	
Huron	Toledo	10160	6000 "	-	
Total		22000		6000	

It is evident that a water stop must be made between Collinwood and Huron and another between Huron and Toledo. Such an arrangement is shown in the following analysis:

Cleveland Division 3500 Ton Train		10,000 gallon tenders H-10 Engine		West Fast and Slow Freight Present 2400 ft. pan at Huron	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Collinwood	Elyria	7400	2300	7700	Stop at Water Plug
Elyria	Huron	4140	5860	3640	Filled to 9500 gals.
Huron	Danbury	2670	6830	3170	Stop at Water Plug
Danbury	Toledo	7490	2510	-	
Total		22000		14510	

The margins from Collinwood to Elyria and from Danbury to Toledo are rather small, indicating that a good portion of the Westbound freight trains must stop for water between these points. Three water stops Westbound with 10,000 gallon tenders appear conservative.

Cleveland Division 3500 Ton Train		15,000 gallon tenders H-10 Engine		West Fast and Slow Freight Present 2400 ft. pan at Huron	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Collinwood	Huron	11840	3160	6000	
Huron	Toledo	10160	1000 Deficit	-	
Total		22000		6000	

Cleveland Division 15,000 gallon tenders West Fast and Slow Freight 3500 Ton Train H-10 Engine Present 2400 ft. pan at Huron					
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Collinwood	Elyria	7700	7300	7700	Stop at Water Plug
Elyria	Huron	4140	10860	3640	Fills to 14,500 gals.
Huron	Toledo	10160	4340	-	
Total		22000		11340	

This indicates that 15,000 gallon tenders will save each Westbound freight train two water stops per trip. For the 105 tenders involved, this would amount to approximately 72.4% of 4195 X 2, or 6074 water stops saved annually.

FREIGHT SERVICE, ERIE DIVISION

EAST OF WESLEYVILLE COALING PLANT:

From Page 28 under Proposition (1), it may be seen that 15,000 gallon tenders would save one water stop per trip with each Eastbound slow freight train and each Westbound fast and slow freight originating from Gardenville Yard. For 105 tenders, this would amount to approximately 72.4% of 5872, or 4251 water stops annually.

WEST OF WESLEYVILLE:

The following series of water performance tables were worked out in an endeavor to determine the number of water stops to be saved from the use of 15,000 gallon tenders on the 105 H-10A locomotives:

Erie Division, West of Wesleyville, 10,000 gallon tenders, Eastbound Fast Freight 4000 Ton Train H-10 Engine Present Track Pans					
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Collinwood	Painesville	5100	4900	4600	Filled to 9500 gallons
Painesville	Ashtabula	5100	4400	5600	Stop for water
Ashtabula	Springfield	3400	6600	2900	Filled to 9500 gallons
Springfield	Wesleyville	5100	4400	-	
Total		18700		13100	

Erie Division, West of Wesleyville, 15,000 gallon tender, East Fast Freight					
4000 Ton Train			H-10 Engine		Present track pans
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Collinwood	Painesville	5100	9900	4600	Filled to 14,500 gals.
Painesville	Springfield	8500	6000	5000	
Springfield	Wesleyville	5100	5900	-	
Total		18700		9600	

The two preceding tables indicate that 15,000 gallon tenders would save each Eastbound fast freight a water stop between Collinwood and Wesleyville. For 105 tenders, this would amount to approximately 72.4% of 6650, or 4815 water stops annually.

Erie Division, West of Wesleyville, 10,000 gallon tenders, Eastbound Slow Freight					
6200 Ton Train			H-10 Engine		Present track pans
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Collinwood	Painesville	5740	4260	5000	Filled to 9260 gallons
Painesville	Ashtabula	5740	3520	6480	Stop for water
Ashtabula	Springfield	6150	3850	5000	Filled to 8850 gallons
Springfield	Wesleyville	7380	1470	-	Rather close margin
Total		25010		16480	

It is noted from the above that unless the engineer is sure of filling a 10,000 gallon tank at Springfield by scooping, it is necessaryv to stop at Springfield pan or the water plug at North Girard.

Erie Division, West of Wesleyville, 15,000 gal. tenders, Eastbound Slow Freight					
6200 Ton Train			H-10 Engine		Present track pans
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Collinwood	Painesville	5740	9260	5000	
Painesville	Ashtabula	5740	8520	6480	Stop at water plug
Ashtabula	Springfield	6150	8840	5000	
Sprinfield	Wesleyville	7380	6460	-	
Total		25010		16480	

The two tables above indicate that 15,000 gallon tenders would

save each Eastbound Slow Freight one water stop between Collinwood and Wesleyville. For 105 tenders, this would amount to approximately 72.4% of 1041, or 753 water stops annually.

Erie Division, West of Wesleyville, 10,000 gal. tender, West Fast & Slow Freight 2210 Ton Train H-10 Engine Present track pans					
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Wesleyville	Springfield	4200	5800	3700	Filled to 9500 gals.
Springfield	Painesville	7000	2500	5000	" " 7500 "
Painesville	Collinwood	3360	4140	-	
Total		14560		8700	

It is noted that with present track pan arrangement and the use of 10,000 gallon freight tenders, Westbound fast and slow freight trains should not stop for water between Wesleyville and Collinwood. The 15,000 gallon tender would give a larger operating margin and of course would save a number of water stops in this class of service, but credit is not being claimed in this report for such benefit. The following table will show performance with 15,000 gallon tenders:

Erie Division, West of Wesleyville, 15,000 Gal tank, West Fast & Slow Freight 2210 Ton Train H-10 Engine Present track pans					
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Wesleyville	Springfield	4200	10800	3700	Filled to 14,500 gals.
Springfield	Painesville	7000	7500	5000	
Painesville	Collinwood	3360	9140	-	
Total		14560		8700	

On the next page will be found a table summarizing all the freight train water stops that may be saved in the Third District from the use of 15,000 gallon tenders back of 105 H-10A locomotives.

SUMMARY OF FREIGHT TRAIN STOPS TO BE SAVED FROM THE USE OF 15,000 GALLON TENDERS ON 105 H-10A LOCOMOTIVES IN THE THIRD DISTRICT

Division	Class of Service	WATER STOPS			
		With 15,000 gallon tank	With 10000 gallon tank	Saved per Trip	Saved Annually
Franklin Main Line	Fast & Slow Both directions	-	-	1	3694
Franklin J. F. & C.	" " "	-	-	1	730
Cleveland L. E. & P.	" " "	-	-	1	2340
Cleveland Main Line	East Fast & Slow	1	2	1	3450
	West " " "	1	3	2	6074
ERIE, East of Wesleyville	East Fast	0	0	0	0
	" Slow	0	1	1	1882
	West from Seneca	0	0	0	0
	" " Gardenville	0	1	1	2369
ERIE West of Wesleyville	East Fast	0	1	1	4815
	" Slow	1	2	1	753
	West from Seneca	0	0	0	
	West " Gardenveille	0	0	0	
TOTAL.....					26116

FINANCIAL STATEMENT, PROPOSITION (5)

Probable savings to be realized with 105 H-10A's in the Third District equipped with 15,000 gallon tenders and a like number of K-2's and K-3's equipped with 10,700 gallon tenders, the latter to be used on Line West.

ITEM	DEBIT	CREDIT
Cost of transferring 105 10,000 gallon tenders from H-10As to passenger service at $500n each $52,500		
Interest and depreciation on above (10½% of $52,000).....	$ 5,512	
Cost of coal pushers for above at $800 each, $84,000..... Interest & depreciation (10½% of $84,500).....	$ 8,820	
Cost of 105 15,000 gallon tenders at $13,500 each Interest & depreciation, (10½% of $1,417,000).....	$148,838	
Credit passenger train stops:		
75% of 11,000 7,500 at Mina		
" " 5,500 4,125 " Graytown, Eastbound		
" " 2,750 2,062 " Air Line Junction, Westbound		
Total 13,687 at $5.00 each.....		$ 68,435
Credit 26,116 freight train water stops saved annually at $10.00 each.....	&&	$261,160
Total.....	$163,170	$329,595
		$163,170
Estimated Net annual saving.....		$166,425

NOTE:
The above does not include credit for the 105 7500 gallon tenders released from the K-2' and K-3's.

Total out of pocket expenditure shown above..... $1,554,000

Years required to return the investment, considering 6% interest Compounded annually..... 7 3/4 years

SUPPORTING DATA, PROPOSITION (6)

Probable saving that would accrue from the use of 15,000 gallon tenders on 74 L-1 locomotives operating on the Toledo and Western Divisions.

The freight service on these two Division is being handled with 74 L-1 locomotives with tenders whose capacity was originally 8000 gallons and are normally called 8000 gallon tenders for even figures, but after the application of stokers these tenders will calibrate only to 7820 gallons water capacity. Hence, in the Preface, and in other parts of this thesis, these tenders may sometimes be spoken of as 8000 gallons tenders, however the actual calibration of the tender was used in working up the water performance tables.

TOLEDO DIVISION:

Using the consumption figures on page 32, the following water performance tables were worked up to show in a general way the advantages to be derived from the use of 15,000 gallon tenders on this Division:

Toledo Division 3500 Ton Train		7820 gallon tenders L-1 Engine		East Fast and Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "TO"	Remarks
Elkhart	Grismore	6500	1320	5000	Rather small margin
Grismore	Corunna	5250	1070	5000	" " "
Corunna	Mina	3500	2570	5250	Stop at water plug
Mina	Stryker	2500	5320	2000	Filled to 7320 gals.
Stryker	Swanton	4500	2820	5000	Stop at Water plug
Swanton	Toledo	2750	5070	** -	
Total		25000		22250	

Toledo Division 3500 Ton Train		15,000 gallon tenders L-1 Engine		East Fast and Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Elkhart	Grismore	6500	8500	5000	
Grismore	Corunna	5250	8250	5000	
Corunna	Stryker	6000	7250	5000	
Stryker	Toledo	7250	5000	-	
Total		25000		15000	No water stops

It appears that 15,000 gallon tenders would save two water stops per train on this Division and Eastbound freight service, amounting to to approximately 7928 water stops annually.

Toledo Division 3400 Ton Train		7,820 gallon tenders L-1 Engine		Westbound Fast Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Delta	5510	m2310	5510	Rather small margin
Delta	Stryker	4350	3470	3950	Filled to 7320 gals.
Stryker	Mina	4060	3260	4560	Stop at water plug
Mina	Corunna	5220	2600	4720	Filled to 7320 gals.
Corunna	Grismore	4640	2680	4640	" " " "
Grismore	Elkhart	5220	2100	-	
Total		29000		23280	Two water stops

Toledo Division 3400 Ton Train		15,000 gallon tenders L-1 Engine		Westbound Fast Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Stryker	9860	5140	5000	
Stryker	Corunna	9280	860	5000	Small margin
Corunna	Grismore	4640	1220	5000	
Grismore	Elkhart	5220	1000	-	
Total		29000		15000	

The two preceding tables indicate that 15,000 gallon tenders would save at least one water stop per trip in Westbound fast freight service on the Toledo Division, amounting to approximately 1692 water stops annually.

Toledo Division 5000 Ton Train		7820 gallon tender L-1 Engine		Westbound Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Delta	7560	2600	7560	Small margin
Delta	Stryker	5400	2420	4900	
Stryker	Mina	6120	1200	6620	Small margin
Mina	Corunna	7560	260	5000	" "
Corunna	Grismore	5040	220	5000	" "
Grismore	Elkhart	4320	900	-	" "
Total		36000		29080	

The above is not satisfactory for everyday operation, hence the following analysis is considered more satisfactory

Toledo Division 5000 Ton Train		7820 gallon tenders L-1 Engine		Westbound Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Swanton	5500	2320	5500	Stop at water plug
Swanton	Wauseon	3900	3920	3900	" " " "
Wauseon	Stryker	3560	4260	3060	Filled to 7320 gals.
Stryker	Mina	6120	1200	6620	Stop at water plug
Mina	Waterloo	5460	2360	5460	" " " "
Waterloo	Corunna	2100	5760	1600	Filled to 7320 gals.
Corunna	Grismore	5040	2280	5000	
Grismore	Elkhart	4320	2960	-	
Total		36000		31140	Four water stops

Toledo Division 5000 Ton Train		15000 gallon tender L-1 Engine		Westbound Slow Freight Present Track Pans	
From	TO	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Toledo	Stryker	12960	2040	5000	
Stryker	Corunna	13680	-6640 Deficit	5000	
Corunna	Grismore	5040	-6680 "	5000	
Grismore	Elkhart	4320	-6000 "	-	Two water stops appear
Total		36000		15000	necessary

From the three preceding tables, it is estimated that 15,000

gallon tenders would save each Westbound slow freight on the Toledo Division two water stops, resulting in approximately 2646 water stops saved annually.

WESTERN DIVISION:

Using the water consumption figures for this Division and shown on page 34 and the number of freight trains (excluding locals) shown on Form OS1b for a year ending May 31, 1926, the following tables were used in estimating the benefit to be derived from the use of 15,000 gallon tenders in freight service on this Division;

Western Division 3300 Ton Train		7820 gallon tender L-1 Engine		East Fast and Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Englewood	Chesterton	5550	2270	5000	Rather small margin
Chesterton	Lydick	5550	1720	5000	" " "
Lydick	Elkhart	3900	2820	-	
Total		15000		1000	

It is noted from the above that a water stop must be made some place before reaching Lydick. The stop is assumed to be at Pinola, however in actual service a good portion of these stops are made at Pine.

Western Division 3300 Ton Train		7820 gallon tender L-1 Engine		East Fast and Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Englewood	Chesterton	5550	2270	5000	Rather small margin
Chesterton	Pinola	2500	4770	3050	Stop at water plug
Pinola	Lydick	3050	4770	2550	
Lydick	Elkhart	3900	3420	-	
Total		15000		10600	

Western Division 3300 Ton Train		15,000 gallon tender L-1 Engine		East Fast and Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Englewood	Chesterton	5550	9450	5000	
Chesterton	Lydick	5550	8900	5000	
Lydick	Elkhart	3900	10000	-	
Total		15000		10000	No water stops

It is estimated that 15,000 gallon tenders would save each Eastward fast and slow freight train one water stop, amounting to approximately 4882 water stops annually.

Western Division 1500 Ton Train		7820 gallon tender L-1 Engine		West Fast and Slow Freight Present Track pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Elkhart	Lydick	4810	3010	4310	Filled to 7320 gals.
Lydick	Pinola	5000	2320	5500	Stop at water plug
Pinola	Chesterton	1660	6160	1160	Filled to 7320 gals.
Chesterton	Pine	3700	3620	4200	Stop at water plug
Pine	Englewood	3330	4490	-	
Total		18500		15170	Two water stops

Western Division 1500 Ton Train		15,000 gallon tender L-1 Engine		West Fast and Slow Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Elkhart	Lydick	4810	10190	4310	Filled to 14500 gals.
Lydick	Chesterton	6660	7840	5000	
Chesterton	Englewood	7030	5810	-	
Total		18500		9310	No water stops

The two table above indicate that 15,000 gallon tenders would save eash Westward fast and slow freight on the Western Division two water stops per trip.

A summary of the water stops saved under this Proposition (6) may be found on the next page.

SUMMARY OF WATER STOPS TO BE SAVED FROM THE USE OF 15,000 GALLON TENDERS BACK OF THE 74 L-1 LOCOMOTIVES ON THE TOLEDO AN WESTERN DIVISIONS

Division	Class of Service	WATER STOPS SAVED			
		With 15,000 gallon tank	With 7,820 gallon tank	Saved Per Trip	Saved Annually
Toledo	East Fast and Slow	0	2	2	7928
Toledo	West Fast	1	2	1	1692
	West Slow	2	2	2	2646
Western	East Fast and Slow	0	1	1	4882
	West " " "	0	2	2	8378
TOTAL, Proposition (6).....					25526

The financial statement in connection with Proposition (6) may be found on the next page.

FINANCIAL STATEMENT, PROPOSITION (6)

Probable saving that would accrue from the use of 15,000 gallon tenders on the 74 L-1 locomotives now operating on the Toledo and Western Divisions.

ITEM	DEBIT	CREDIT
Cost of purchasing 74 15,000 gallon tenders at $13,500 each..... $999,000		
Interest and depreciation on above, (10½% of $999,000)	$104,895	
Credit 25,526 Freight service water stops saved annually at $10.00 each.....		$255,260
Total.....	$104,895	$255,260
		104,895
Estimated Net Annual Saving.....		$150,365
Out of pocket expenditure.....		$999,000
Years required to return the investment, considering 6% interest Compounded annually.....		5 3/4 years

NOTES:

The above does not include credit for the 74 7820 gallon tenders released.

The above does not include the benefit to be derived from the use of these 15,000 gallon tenders on the Detroit Branch of the Toledo Division and on the main line of the Michigan Division via Adrain and Hillsdale.

SUPPORTING DATA, PROPOSITION (7)

Probable savings that would accrue if the H-5 locomotives on the Hudson Division were all equipped with 15,000 gallon tenders.

The following water consumption figures were obtained through a number of test trips made in fast freight service on the Hudson Division during the month of February, 1926:

BETWEEN	GALLONS CONSUMED	
	WESTWARD	EASTWARD
72nd St. Terminal and Croton	5980	4900
Croton " Clinton Point	4600	4000
Clinton Point " Poughkeepsie	1840	9000
Poughkeepsie " Tivoli	4140	3600
Tivoli " Selkirk Yard	6440	5600
Average Consumption.....	23000	19000
Operating margin.....	3000	3000
Total average requirements.....	26000	22000
To be supplied en route:		
15,000 gallon tender....	11000	7000
7,500 gallon tender....	18500	14500

The series of water performance tables following on the next page will indicate the probable benefit to be derived through the use of 15,000 gallon tenders on the Hudson Division.

Hudson Division 2000 Ton Train		7500 gallon tender H-5 Engine		East Fast Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
Selkirk Yard	Tivoli	5600	1900	4500	
Tivoli	Clinton Point	4500	1900	45000	
Clinton Point	Croton	4000	1400	3500	
Croton	72nd St.	4900	1000	-	Two water stops
Total		19000		12500	appear necessary

Hudson Division 2000 Ton Train		15,000 gallon tender H-5 Engine		East Fast Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scopped at "To"	Remarks
Selkirk Yard	Tivoli	5600	9400	4500	
Tivoli	Clinton Point	4500	9400	4500	
Clinton Point	Croton	4000	9900	3500	
Croton	72nd Street	4900	8500	-	
Total		19000		12500	No Water stops

15,000 gallon tenders would save each Eastbound Fast freight train two water stops per trip on the Hudson Division.

Hudson Division 2000 Ton Train		7500 gallon tenders H-5 Engine		West Fast Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
72nd St.	Croton	5980	1520	3500	
Croton	Clinton Point	4600	420	4500	
Clinton Point	Tivoli	5980	-1060 Deficit	4500	
Tivoli	Selkirk Yard	6440	-3000	-	
Total		23000		12500	

With a 7500 gallon tender, each Westward fast freight on the Hudson Division must stop for water between 72nd Street and Croton, and again between Tivoli and Selkirk.

Hudson Division 2000 Ton Train		7500 gallon tender H-5 Engine		West Fast Freight Present Track Pans	
From	To	Gallons Used	In Tender at "To"	Scooped at "To"	Remarks
72nd Street	Croton	5980	9020	3500	
Croton	Clinton Point	4600	7980	4500	
Clinton Point	Tivoli	5980	6440	4500	
Tivoli	Selkirk	6440	4500	-	
Total		23000		12500	No water stops

The four preceding tables indicate that 15,000 gallon tenders in freight service on the Hudson Division would save each fast or slow freight train two water stops in each direction. Considering freight trains (excluding locals) shown on Form O8la for a year ending July 31st, 1926, 15,218 freight water stops annually would probably be saved. As of August 15, 1926, there were 25 H-5 locomotives assigned to the Hudson Division, of which eleven were equipped with 15,000 gallon tenders. If the remaining fourteen (56%) were so equipped, it is quite probable that 56% of 15,218, or 8,522 water stops wpuld be saved annually.

The finanvial analysis pertaining to this proposition may be found on the next page.

FINANCIAL STATEMENT, PROPOSITION (7)

ITEM	DEBIT	CREDIT
Cost of purchasing fourteen 15,000 gallon tenders at $13,500 each..... $189,000		
Interest and depreciation on expenditure named above, 10½% of $189,000.....	$19,845	
Credit 8,522 freight water stops saved annually at $10.00 each.....		$85,220
Total.....	$19,845	$85,220
		19,845
Estimated Net annual saving.....		$65,375

Out of pocket expenditure..... $189,000

Years required to return investment, considering six per cent interest compounded annually..... 2 3/4 years

NOTE:

The above analysis does not include credit for the fourteen 7500 gallon tenders released for scrap or other classes of service.

SUPPORTING DATA, PROPOSITION (8)

Purchase of thirty five 10,700 gallon tenders, in addition to the 105 10,700 gallon tenders removed from H-10A locomotives and suggested under Proposition (5), in order to complete the installation to the 140 K-2 and K-3 locomotives operating on the main line of the Line West.

Under Proposition (5), it has been estimated that if the 140 main line K-2's and K-3's on Line West were equipped with 10,700 gallon tenders, approximately 19,250 passenger train stops would be saved annually. Hence, the thirty five tenders involved in this Proposition should save 25% of 19,250, or 4813 passenger train stops annually.

The Financial Analysis would be as follows:

Debit the interest and depreciation of the expenditure for thirty five 10,700 gallon tenders purchased at $10,500 each. (10½% of $367,500).....	$38,588
Credit 4813 passenger train stops saved annually @ $5.00 each..	$24,065
Estimated Net Annual Loss.....	$14,523

The value of the thirty five 7500 or 8000 gallon tenders released from the K-2's and K-3's by this Proposition has not been considered in the above. Even if this Proposition had shown a net annual saving, it is believed inadvisable to make this large an expenditure on the K-2's on account of their age and the probability of their being replaced with more modern power within the course of several years.

SUPPORTING DATA, PROPOSITION (9)

Purchase of 10,700 gallon tenders for the 226 Line East K-2 and K-3 locomotives in main line service.

It is estimated that 10,700 gallon tenders on main line passenger engines would save one coal stop between Harmon and Buffalo, amounting to approximately 21,000 trains annually. Results found with the Dynamometer Car indicate 10,700 gallon tenders in passenger service would permit the removal of the track pans at Schodack and Schenectady with out detriment to freight train operation, amounting to approximately $18,700 saving annually in the cost of operating and maintaining these two track pan stations. This is based upon a three year average of the cost of operating and maintaining the track pan station at Yosts, and assuming that the water plug and pumping plant at Schodack can be eliminated. The enginehouse and yard at Schenectady would require retaining the pumping plant at that point.

FINANCIAL STATEMENT, PROPOSITION (9)

ITEM	DEBIT	CREDIT
Interest and depreciation of the expenditure of $2,373,000 for 226 10,700 gallon tenders at $10,500 each	$249,165	
Credit 21,000 passenger train stops saved annually at $5.00 each		$105,000
Credit approximate saving in maintenance through elimination of the track pans at Schodack and Schenectady		$ 18,700
Total	$249,165	$123,700
Estimated Net Annual LOSS	123,700 $125,465	

COST PER HOUR FREIGHT TRAIN DELAY

Based on operating costs of NYCRR (excluding O.C. Lines)

during the year 1925

ITEM	COST PER HOUR DELAY
Wages of enginemen	$2.818
Wages of trainmen	3.451
Fuel	32395
Other locomotive supplies	.374
Car repairs (Average train of 80 cars)	12.343
Interest &depreciation of the locomotive for one hour, ($77,500)	.920
" " " " 88 frt. cars " " " ($2000 each)	1.918
TOTAL	$25.219

NOTE:

The above was worked up in accordance with the method recommended by the Committee of Economies of Railway Signalling of the Signal Section of the American Railway Association at their convention held in Chicago on March 13th and 14th, 1924.

METHOD OF FIGURING APPROXIMATE COST OF STOPPING AND STARTING A TRAIN

In an attempt to place a value in dollars and cents upon stopping a passenger train, the following method was used:

To express the cost of stopping a train in dollars and cents, it is necessary to express the value of the stop in equivalent miles run, as the best figures available covering the cost of passenger train operation are average values per mile run.

It is a fact that when a train is stopped it loses an equivalent mileage equal to the mileage the train would have run had it continued, without making the stop, at the original rate of speed.

The value of the stop will be the sum of the equivalent miles run in bringing the train from a specified speed to a stop and the equivalent miles run in restoring the train to its original speed, neglecting the time it is at a stand-still.

Since energy is the capacity for performing work, the energy dissipated in making a stop divided by the work required to move the train a mile will give a factor which represents the value of a stop in equivalent miles run.

In actual train operation, braking power and locomotive drawbar pull are constantly varying factors, the precise values of which are not capable of analysis except in specific cases, and then only approximately. Therefore, in the following analysis it is assumed that the rate of acceleration and deceleration is constant at all times.

The work necessary to move a train depends upon the weight of the train, rolling resistance, grade resistance, (if on a grade) and air resistance. For analysis, air resistance will be neglected. Therefore, the work necessary to move a train a mile in foot pounds is:

$$5{,}280 \times R$$

where R = total rolling resistance in pounds and equals the weight of the train in tons times resistance in pounds per ton at given speed.

The fundamental formula for energy is $\frac{1}{2}MV^2$, where M = mass, and V = velocity of train in feet per second.

$M = \frac{W}{2g}$, W = weight of train in pounds, g = 32.16

Therefore, energy $= \frac{WV^2}{64.32}$

When a train makes a stop going up a grade, the effect of the grade resistance is to reduce the amount of energy to be absorbed and to increase the amount of energy that is required at starting, as against the amount of energy absorbed or required on level tangent track. In other words, when going up grade, it is easier to stop and more difficult to start than on level tangent track, and vice-versa when going down grade.

Let G = grade resistance in pounds

Therefore the value of making a stop ascending a grade in equivalent miles run = the value of coming to a stop plus value of regaining speed, or:-

$$\frac{\frac{(W-G)V^2}{64.32}}{5280 \times R} + \frac{\frac{(W+G)V^2}{64.32}}{5280 \times R} = \frac{(W-G)V^2 + (W+G)V^2}{64.32 \times (5280 \times R)} \text{ Miles, (Formula "A")}$$

Similarly the value of making a stop descending a grade in equivalent miles run $= \frac{(W + G)V^2 + (W - G)V^2}{64.32 \times (5280 \times R)}$, which is the same value as a stop ascending a grade.

Costs per passenger train mile taken from Form OS-c,"Locomotive and Train Costs", for the first six months of 1926:

ITEM	COST PER PASSENGER TRAIN MILE
Locomotive repairs	$0.267
Train enginemen	$0.128
Locomotive Fuel	$0.152
Other locomotive supplies	$0.021
Trainmen	$0.146
Train supplies and expense	$0.036
Enginehouse expense	$0.052
TOTAL	$0.802

EXAMPLE

Main line limited passenger train of twelve 70 ton cars (840 tons); K-3q Pacific passenger locomotive; level tangent track; speed from which stop is made - 60 miles per hour.

Weight Characteristics of K-3q Engine

Weight on drivers	194,500 lbs.
" " engine and triler trucks	101,000 "
" " engine, working order, total	295,500 "
" " tender at two thirds load	138,800 "
" " engine and tender, tender 2/3 load	434,300 "

Engine friction, Drivers,	97 tons	X 25 lbs per ton	2425 lbs
" " Trucks ,	60 "	X 3.62 " " "	181 "
Tender Truck friction	69 "	X 3.02 " " "	209 "
Total locomotive and tender resistance			2815 "
Weight of train			1,680,000 "
Weight of engine and tender, tender 2/3 loaded			434,300 "
Total weight of train and locomotive			2,114,300 "

From Professor Schmidt's tests, passenger car resistance of a 70 ton car at 60 miles per hours is 6.5 pounds per ton.

Therefore W = 2,114,300 lbs.

R = (6.5 X 840) + 2815 = 8275 lbs

V = 88 feet per second

G = 0

Substituting in formula "A" on page 68 the above values, it is found that the equivalent miles run is 11.65 miles.

Then the total cost of the stop would be 11.65 X $0.802 = $9.34

Locomotive repairs and enginehouse expense in the opinion of some authorities are not directly affected by passenger train stops. Deducting these two figures from the total of $0.802, we have left $0.483 which might be termed as the direct cost of the stop.

The direct cost would then be 11.65 X $0.483 = $5.65

For the purpose of the track pan study, a figure of $5.00 per passenger train stop was used to arrive at the potential reduction in operating expense due to the elimination of such stops.

WATER CONSUMPTION IN FAST FREIGHT SERVICE ON THE MOHAWK DIVISION

A number of test trips made in fast freight service on the Mohawk Division during February and March, 1926, suggests the following water consumption figures between various points on the Division:

	GALLONS CONSUMED	
BETWEEN	WESTBOUND	EASTBOUND
Selkirk Yard and Yosts Pan	9120	9120
Yosts pan " St. Johnsville	2160	2160
St. Johnsville " Herkimer pan	2160	2160
Herkimer pan " Rome pan	4800	4800
Rome pan " Dewitt Yard	5760	5760
Average Consumption	24000	24000
Operating margin	3000	3000
Average requirements	27000	27000
Capacity of tender	15000	15000
To be supplied en route	12000	12000

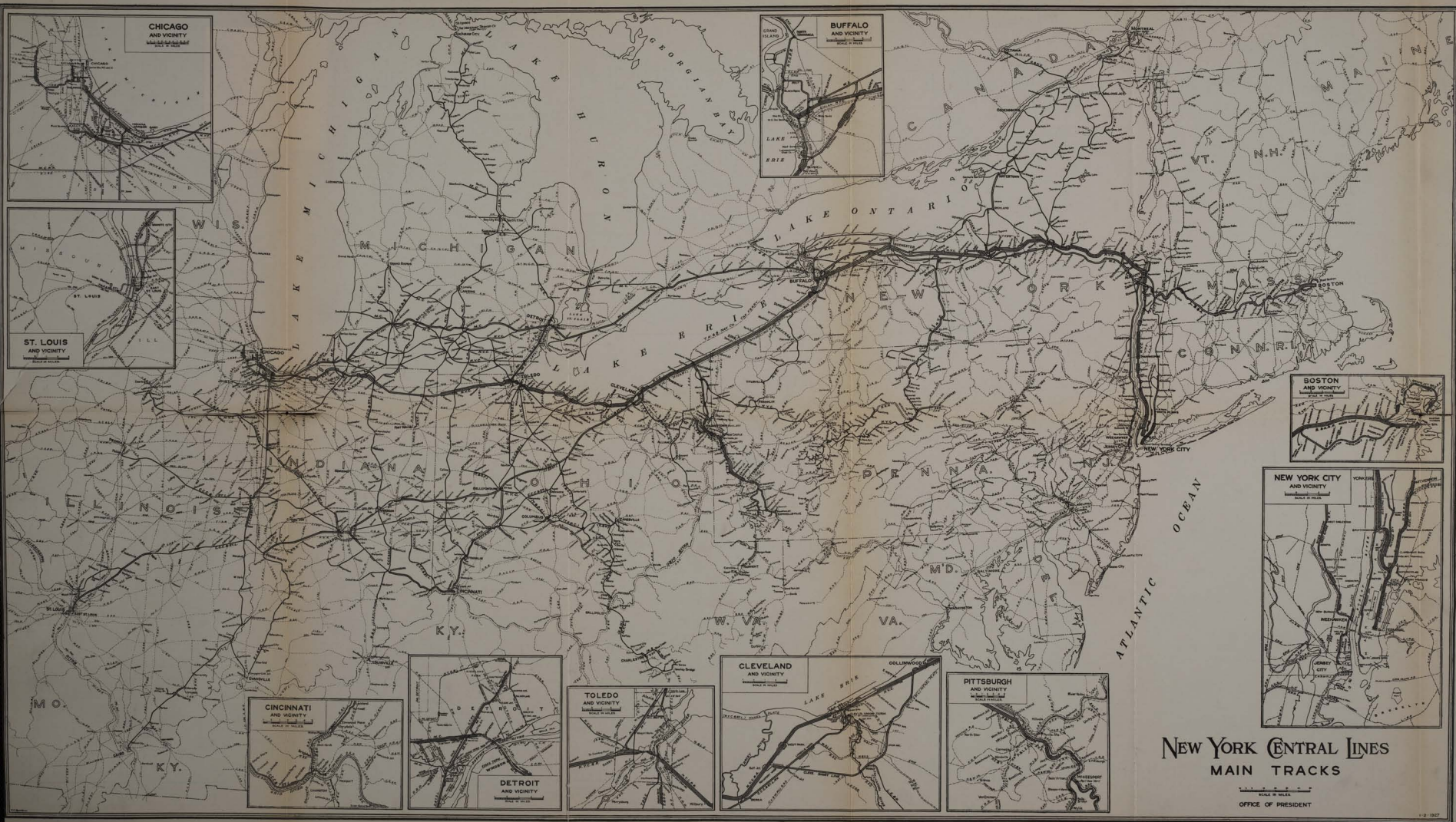
WATER CONSUMPTION IN FAST FREIGHT SERVICE ON THE SYRACUSE DIVISION

A number of test trips made in fast freight service on this Division during February and March 1926 suggests the following water consumtpion figures between various points on the Division:

BETWEEN	GALLONS CONSUMED	
	WESTBOUND	EASTBOUND
Dewitt Yard and Seneca River pan	5980	6000
Seneca River pan " East Palmyra "	3900	3360
East Palmyra " " Churchville "	6240	6960
Churchville " " Wende "	8320	4080
Wende " " Buffalo	1560	3600
Average consumption	26000	24000
Operating margin	3000	3000
Average requirements	29000	27000
Capacity of tender	15000	15000
To be supplied en route	14000	12000

SECTION (E).

ILLUSTRATIONS



New York Central Lines

MAIN TRACKS

SCALE IN MILES

OFFICE OF PRESIDENT

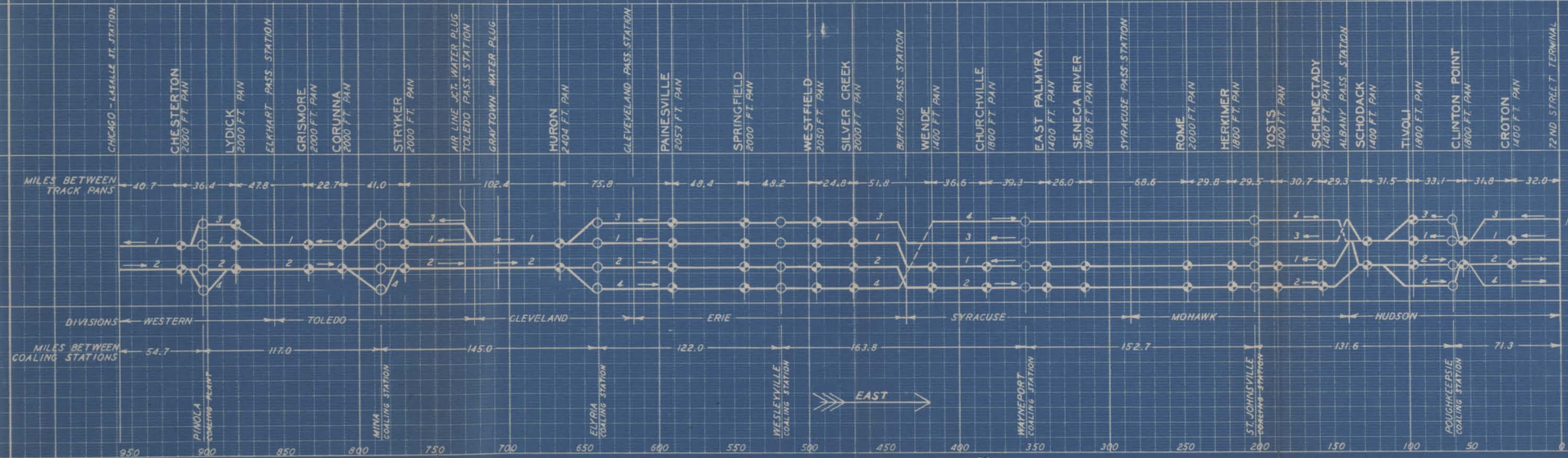
1-2-1927

ROBERT P. MCCUNE, PHOTO-LITHO, 170 NASSAU, N.Y.C.

TRACK PAN STATIONS

COALING STATIONS

PLATE NO. II



NOTE:- MAIN LINE TRACKS ARE INDICATED BY NUMBERS 1 TO 4 INCLUSIVE AND ARROWS SHOW NORMAL DIRECTION OF TRAFFIC. TRACKS 1 & 2 ARE NORMALLY USED FOR PASSENGENGER AND 3 & 4 FOR FREIGHT.

NEW YORK CENTRAL RAILROAD CO.

LOCATION OF TRACK PANS AND COALING STATIONS.

TRACKS 1-2-3 & 4

BETWEEN 72ND ST. NEW YORK AND CHICAGO.

DRAWN BY- J.L.D.
CHECKED BY- C.F.P.

SKETCH A

RELATION BETWEEN SPEED AND AMOUNT OF WATER SCOOPED

The relation between train speed and the number of gallons of water scooped per lineal foot of pan is dependent upon a number of variables, namely,- height of water in the pan; load upon the tender; the depth that the dipper drops into the pan; and the ability of the air to escape from the tender while scooping. These variables no doubt account for the scattered positions of the points on the curves shown on Plates III and IV.

It will be noted that the curve for freight service slopes more sharply than that for passenger service. We believe that the passenger service information is more accurate and representative of actual conditions than that for freight service due to the fact that the passenger data was obtained by use of the Dynamometer where a greater degree of accuracy in measurements is possible. The freight service data was made only roughly in order to determine the most representative speed at which in actual service the average amount of water is scooped.

The permissible speed in scooping water in passenger service is 45 miles per hour. At this speed the average amount of water scooped per linear foot of pan is 2.75 gallons, a figure used where it was necessary to make an academic analysis of water requirements.

From observation it was found that the average speed of freight trains over track pans was between 30 and 35 miles per hour. At the latter speed the amount of water scooped per linear foot of pan was 2.50 gallons and this was the figure used in making up the probable water performance tables for this class of service.

PLATE NO. III

NEW YORK CENTRAL RAILROAD CO.

RELATION BETWEEN SPEED AND GALLONS OF WATER SCOOPED

PASSENGER SERVICE

DYNAMOMETER CAR DATA

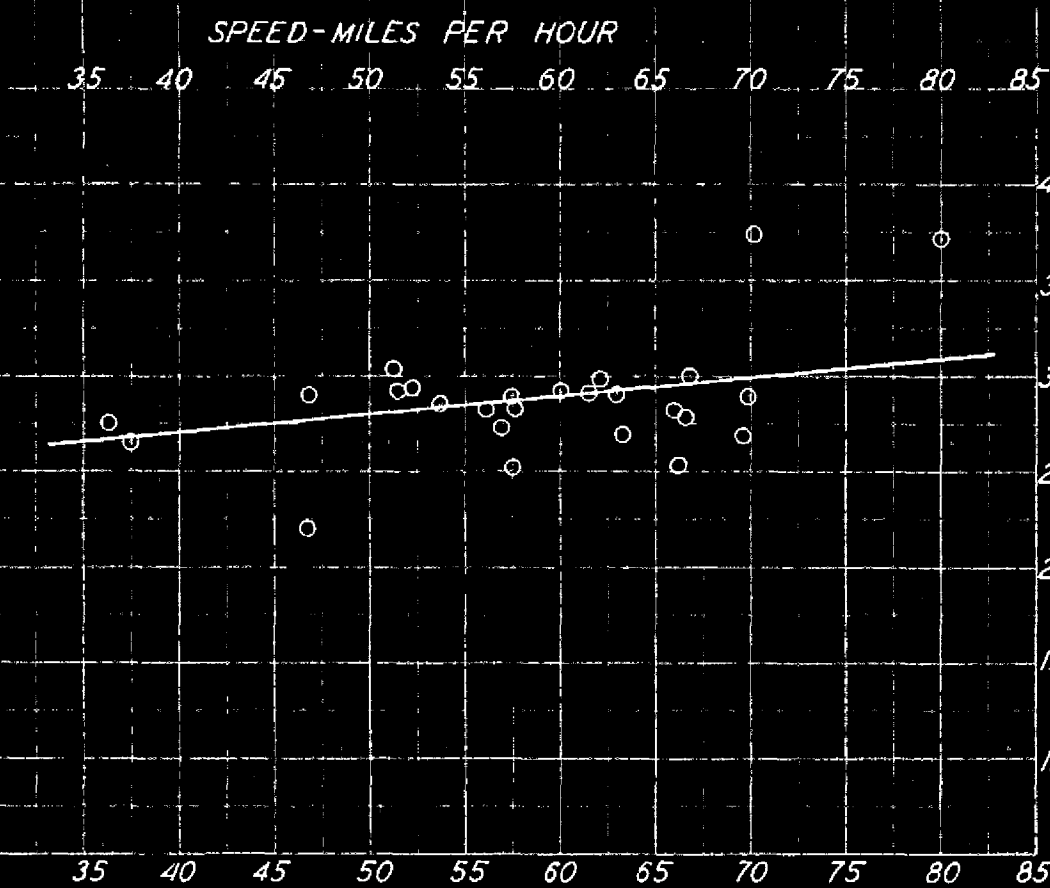


PLATE NO. IV

NEW YORK CENTRAL RAILROAD CO.

RELATION BETWEEN SPEED AND GALLONS OF WATER SCOOPED

FREIGHT SERVICE

NOTE -
THE DATA FROM WHICH THIS CURVE WAS PLOTTED WAS DEVELOPED FROM PERSONAL OBSERVATIONS MADE WHILE RIDING H-10 & L-1 FREIGHT LOCOMOTIVES ON LINE WEST OF BUFFALO.

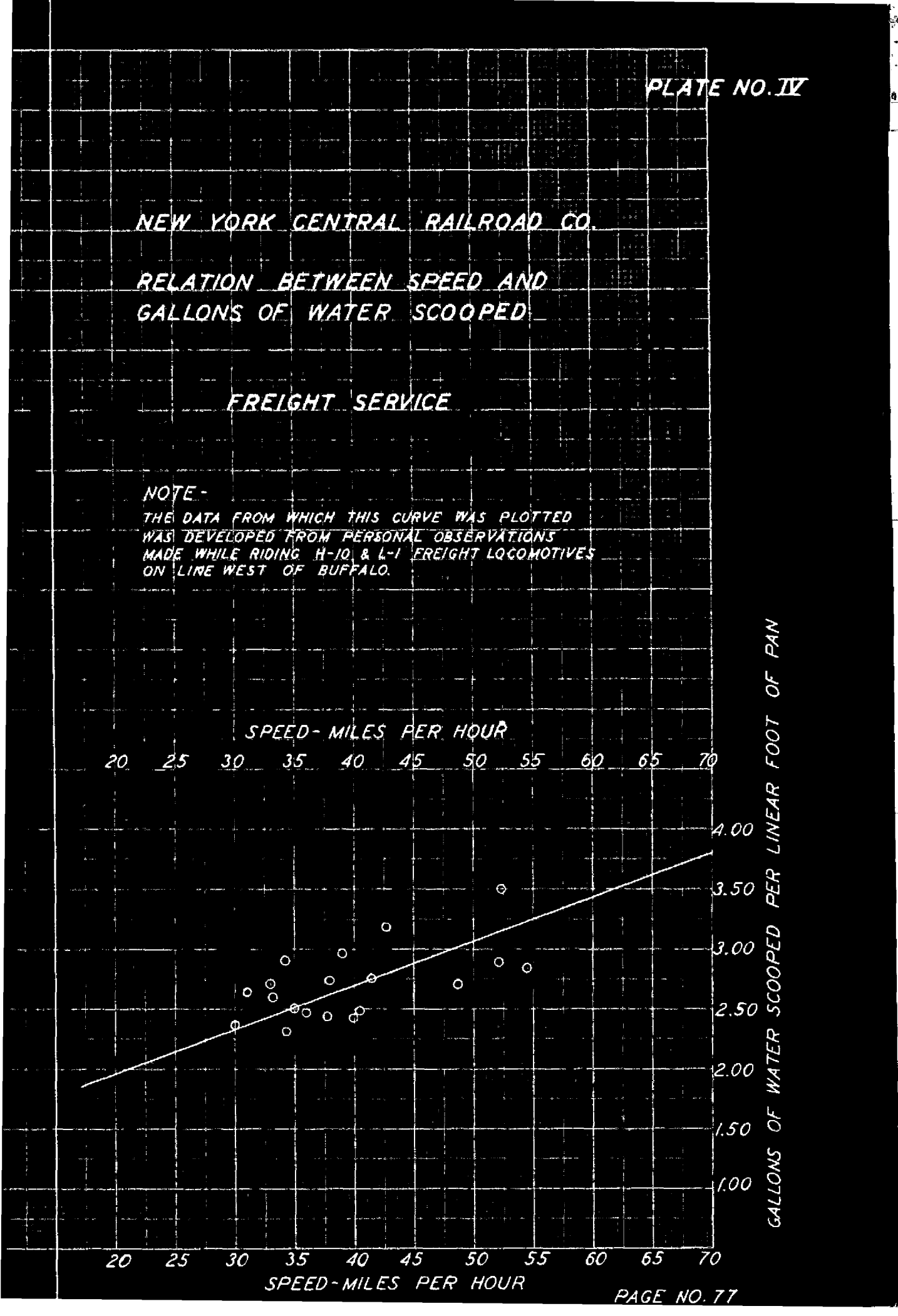
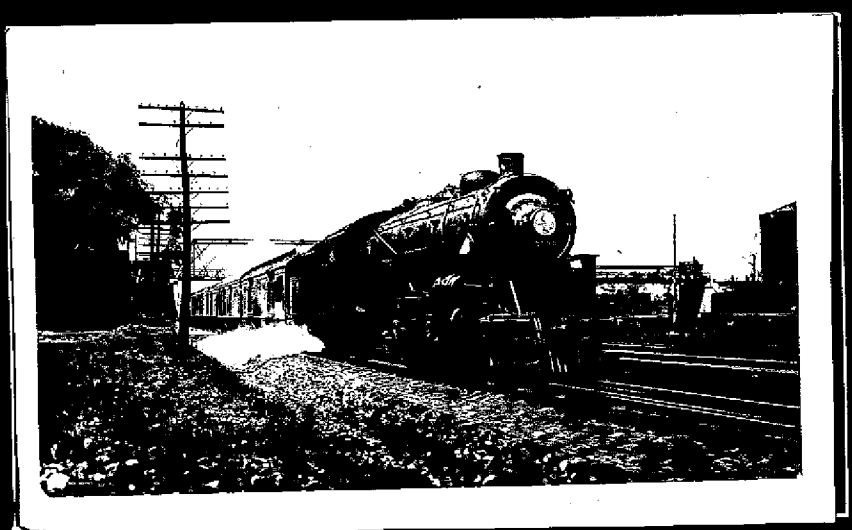


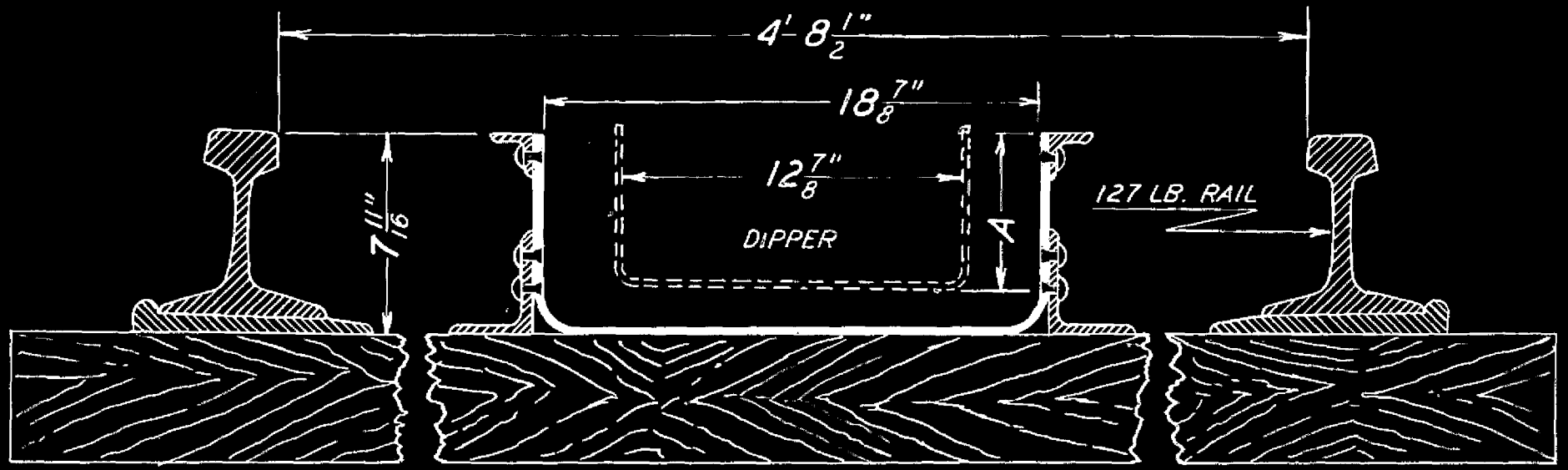
PLATE NO. V

NEW YORK CENTRAL RAILROAD CO.

TYPICAL TRACK PAN INSTALLATION
LINE EAST



K-3 LOCOMOTIVE SCOOPING WATER



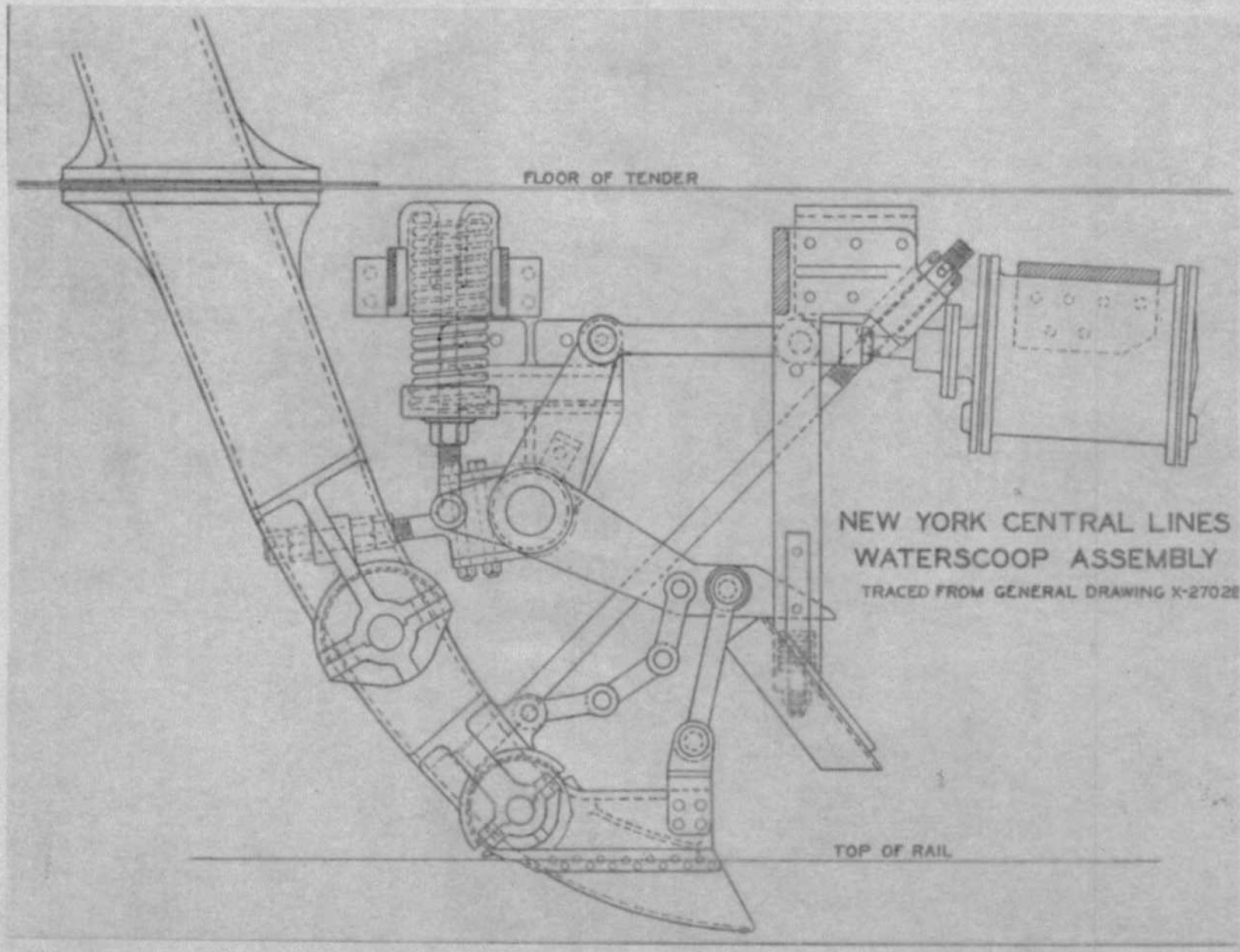
DIMENSION "A"
MIN. 4 1/2"
MAX. 5 1/2"

NEW YORK CENTRAL LINES

CROSS-SECTION OF TYPICAL TRACK PAN INSTALLATION

PLATE NO. II

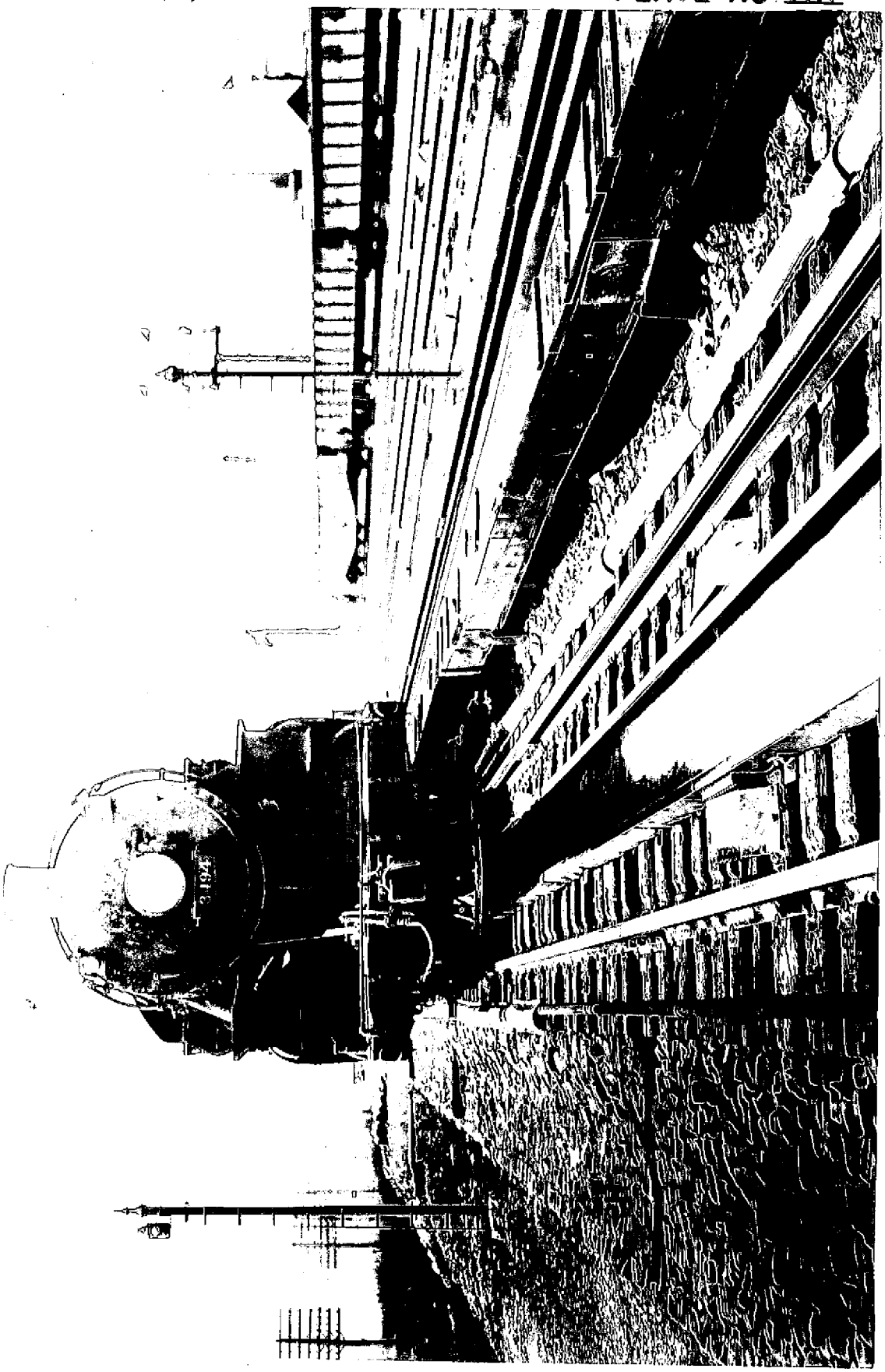
PAGE NO. 79



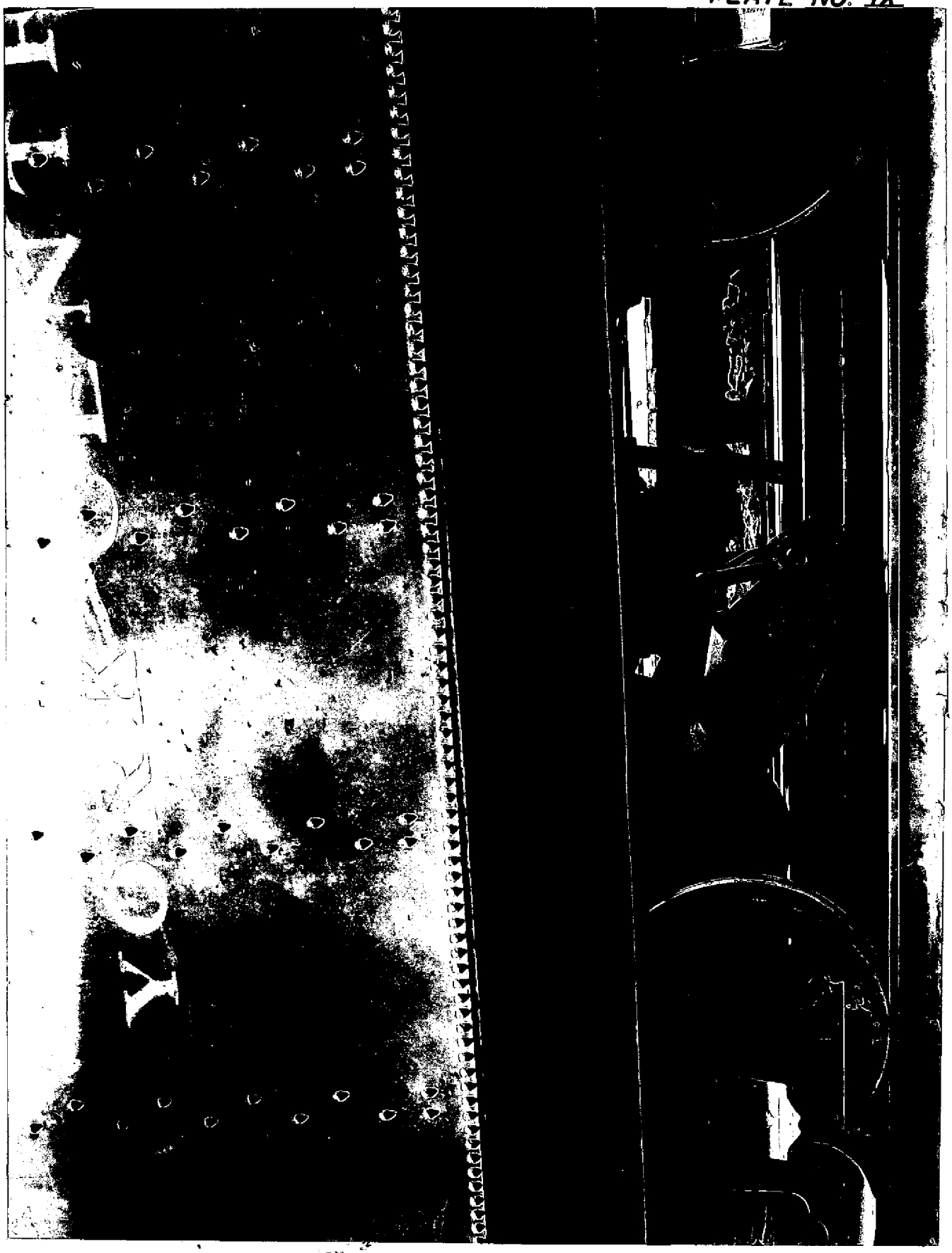
NEW YORK CENTRAL LINES
WATERSCOOP ASSEMBLY
TRACED FROM GENERAL DRAWING X-27028

PLATE NO. VII

PLATE NO VIII

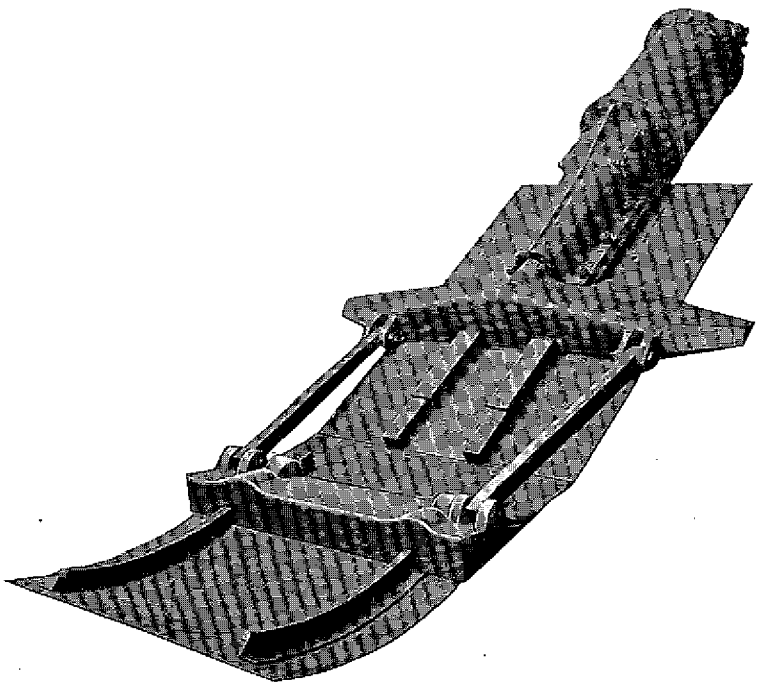


LOCOMOTIVE ON TRACK PAN

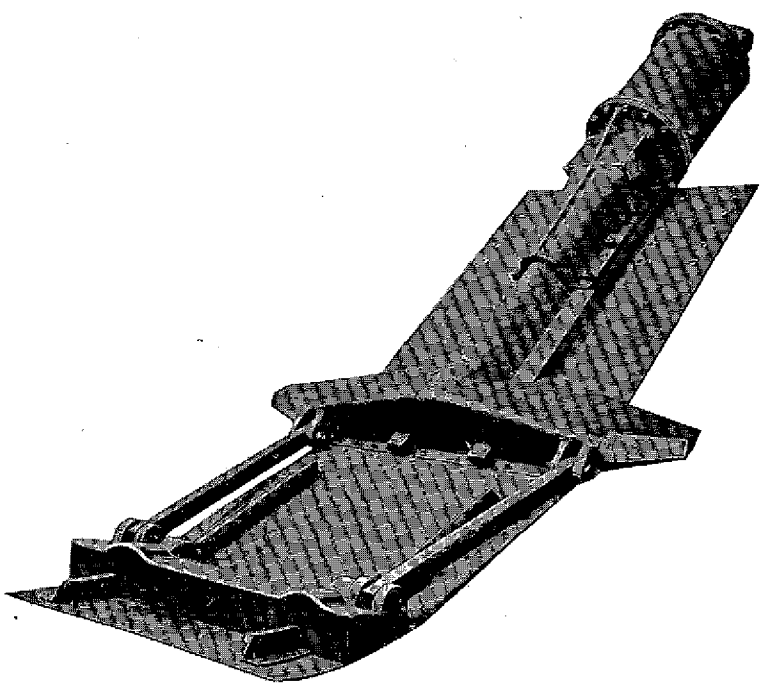


DIPPER IN POSITION FOR SCOOPING

PLATE NO. X



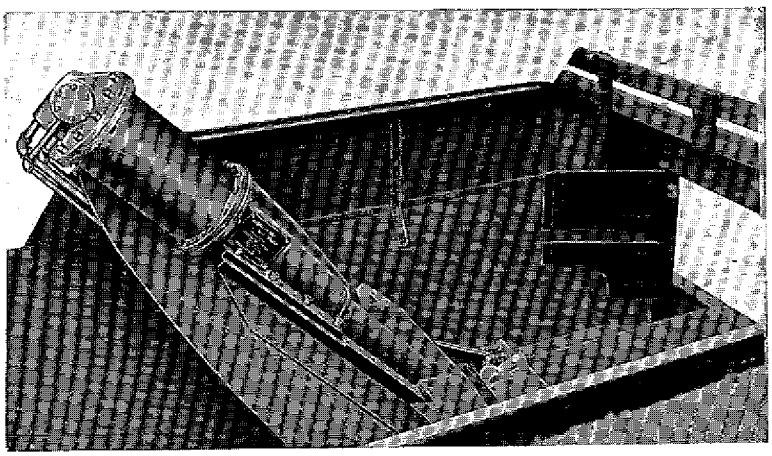
UPSTROKE POSITION



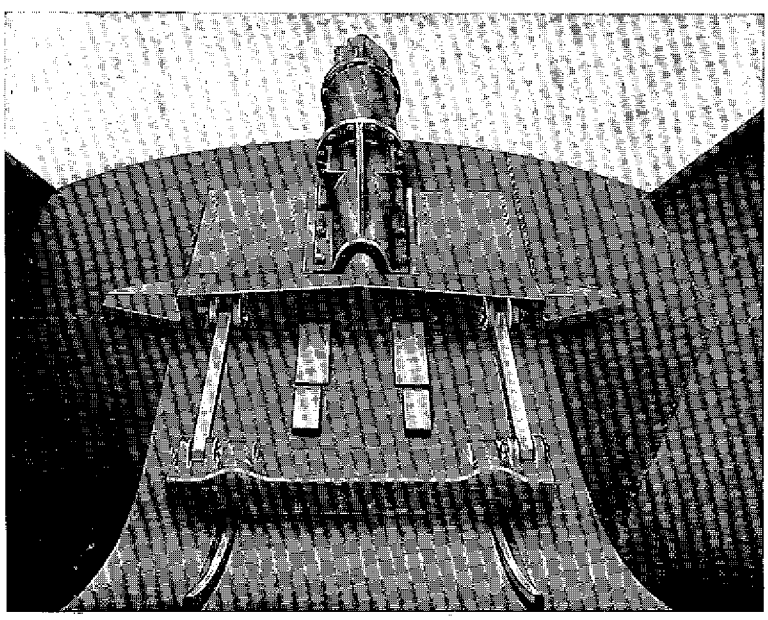
DOWNSTROKE POSITION

SLOPE SHEET COAL PUSHER

LOCOMOTIVE STOKER COMPANY
PITTSBURGH, PA.



TOP VIEW



END VIEW

SLOPE SHEET COAL PUSHER

LOCOMOTIVE STOKER COMPANY
PITTSBURGH, PA.

NEW YORK CENTRAL RAILROAD CO.
15000-GALLON LOCOMOTIVE TENDER
TRUCK ASSEMBLY

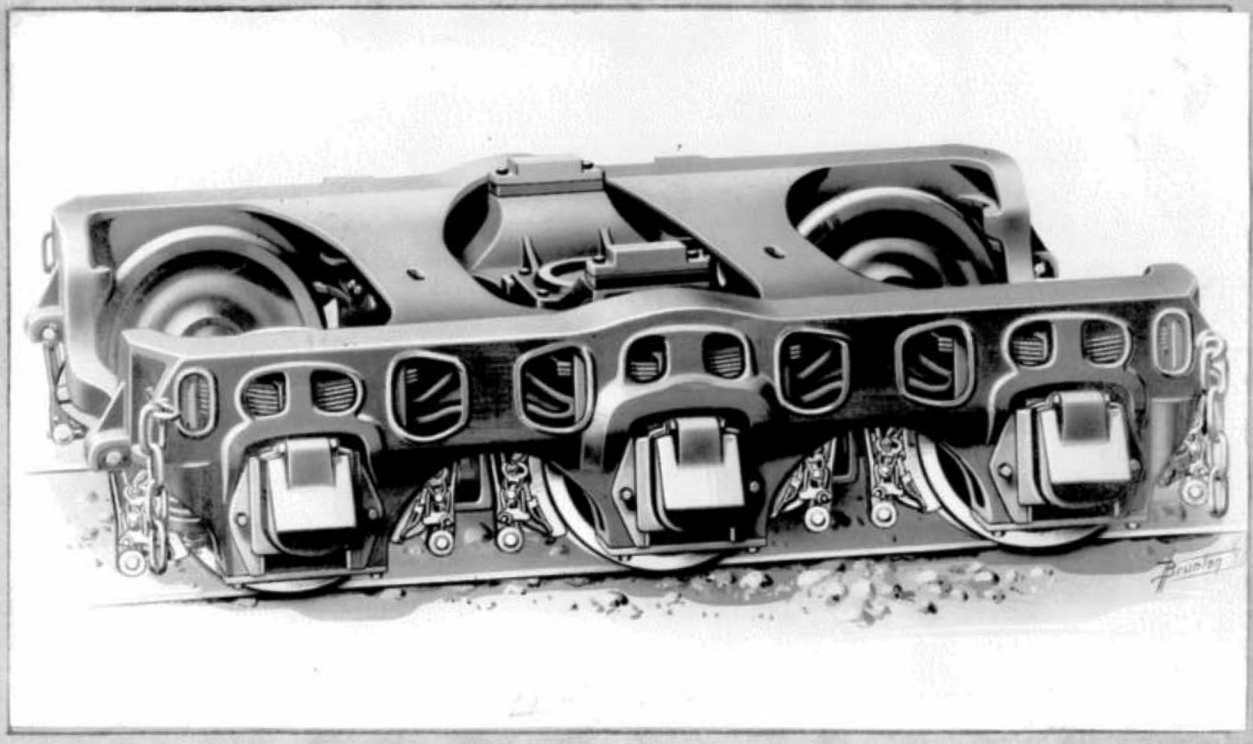


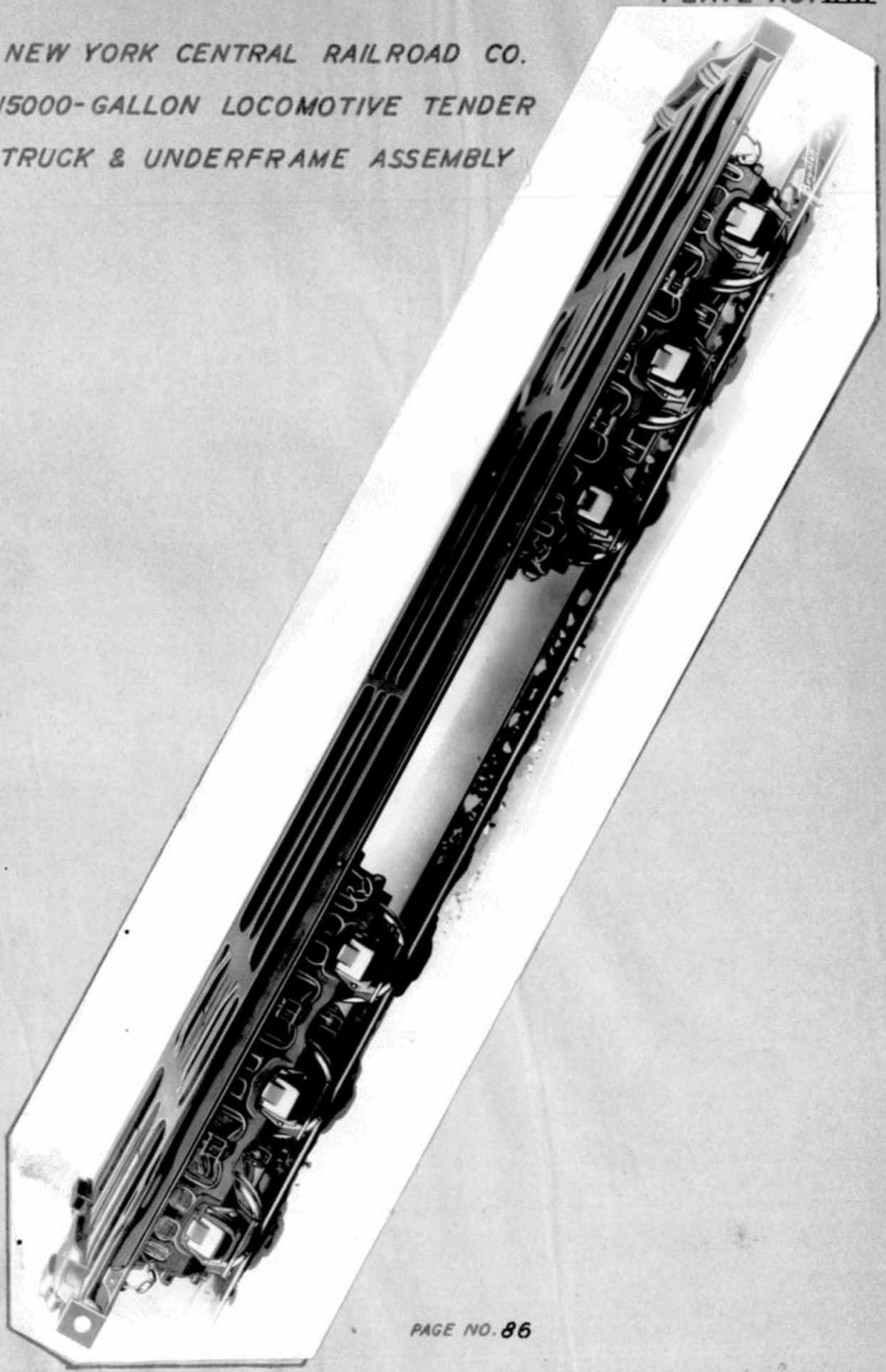
PHOTO. BY COMMONWEALTH STEEL COMPANY
ST. LOUIS MO.

PLATE NO. XIII

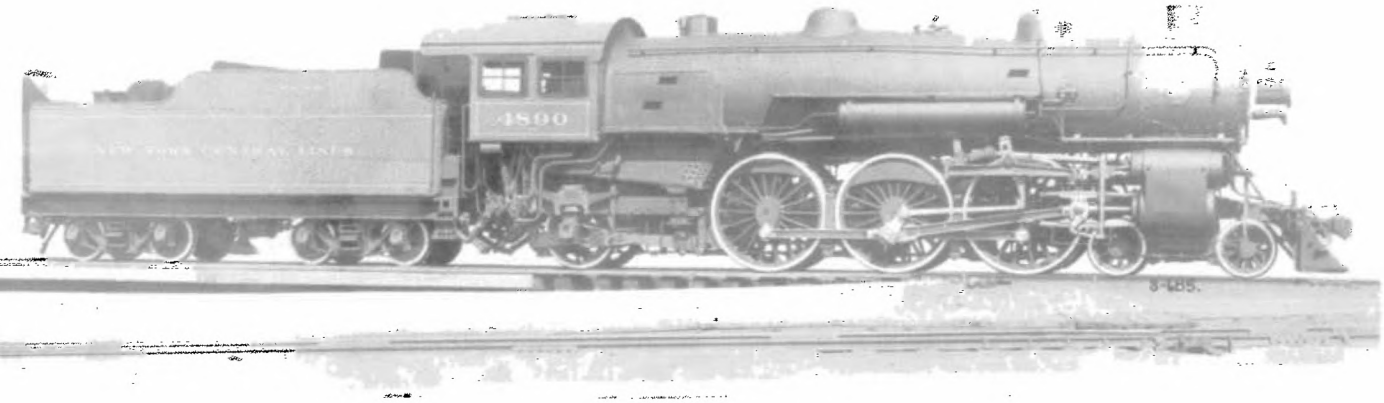
NEW YORK CENTRAL RAILROAD CO.

15000-GALLON LOCOMOTIVE TENDER

TRUCK & UNDERFRAME ASSEMBLY



NEW YORK CENTRAL LINES CLASS, K-2 L



BUILT BY
AMERICAN LOCOMOTIVE COMPANY
NEW YORK

Class, 462 267

Road Number, 4890

GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam.	Stroke		Diameter	Pressure	Length	Width	Number	Diameter	Length
4'-8½"	22"	28"	79"	72"	200 lbs.	108⅛"	75¼"	382	2"	20'-0"

WHEEL BASE			WEIGHT IN WORKING ORDER--POUNDS.				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
14'-0"	36'-6"	67'-11"	48000	170500	48000	266500	164500

FUEL	HEATING SURFACES, SQ. FT.				GRATE AREA SQ. FT.	MAXIMUM TRACTIVE POWER	FACTOR OF ADHESION
Kind	Tubes	Fire Box	Water Tubes	Total			
Soft Coal	3981.6	200	28.4	4210	56.5	49200 lbs.	3.84

Tender, Type 8-Wheeled. Capacity Water 8000 Gals. Fuel 14 Tons.

NEW YORK CENTRAL LINES CLASS, K-3 Q

BUILT BY
AMERICAN LOCOMOTIVE COMPANY
NEW YORK

Class, 462 S 296 **Road Number, 3267**

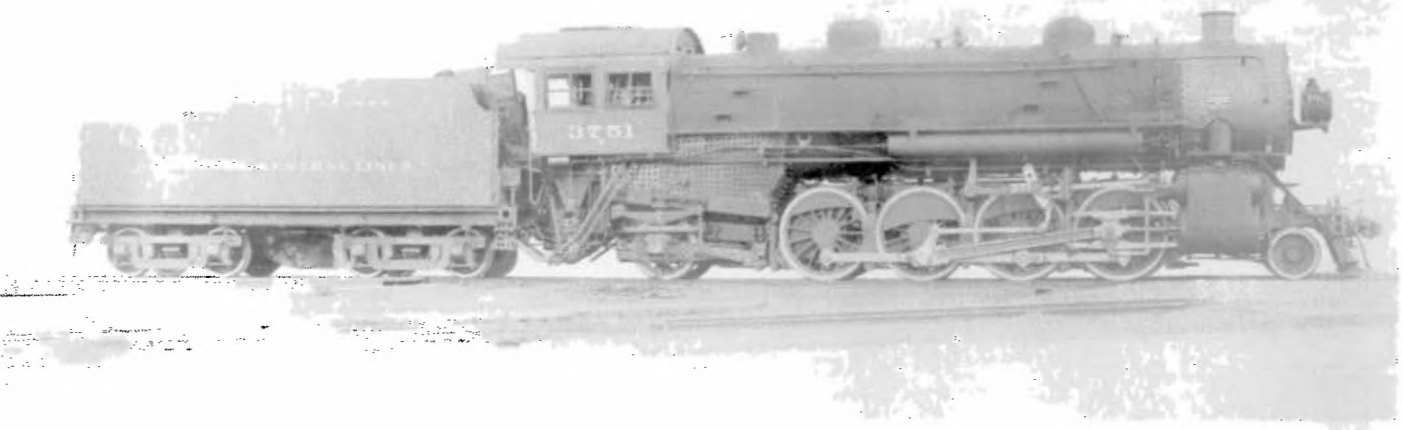
GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam.	Stroke		Inside Dia.	Pressure	Length	Width	Number	Diameter	Length
4′-8½″	23½″	26″	79″	70⅝″	200 lbs.	108⅛″	75¼″	175 32	2¼ 5½	21′-6″

WHEEL BASE			WEIGHT IN WORKING ORDER—POUNDS				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
14′-0″	36′-6″	68′-1″	44000	194500	57000	295500	168700

FUEL	HEATING SURFACES—SQUARE FT.						GRATE AREA SQ. FT.	MAXIMUM TRACTIVE POWER		FACTOR OF ADHESION	
Kind	Tubes	Flues	Fire Box	Arch Tubes	Total	Superheater		Engine	Booster	Drivers	Trailer
Soft Coal	2207	986	204	27	3424	838	56.5	30900 lbs.	9700 lbs.	6.29	5.87

Tender, Type 8-Wheeled. Capacity, Water, 8000 Gals Fuel, 12 Tons

NEW YORK CENTRAL LINES CLASS, H-5 H



BUILT BY

AMERICAN LOCOMOTIVE COMPANY

NEW YORK

Class, 282 S 284 **Road Number, 3751**

GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam.	Stroke		Inside Diameter	Pressure	Length	Width	Number	Diameter	Length
4′-8½″	25″	32″	63″	80″	180 lbs.	108⅛″	75¼″	265 36	2″ 5½″	20′-6″

WHEEL BASE			WEIGHT IN WORKING ORDER—POUNDS				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
16′-6″	35′-0″	67′-8″	24000	215000	45000	284000	154500

FUEL	HEATING SURFACES, SQUARE FT.						GRATE AREA SQ. FT.	MAXIMUM TRACTIVE POWER	FACTOR OF ADHESION
Kind	Tubes	Flues	Fire Box	Arch Tubes	Total	Superheater			
Soft Coal	2831.4	1033.7	204.2	26.7	4096	880.4	56.5	46600 lbs.	4.43

Tender, Type 8 Wheeled Capacity, Water, 7500 Gals Fuel, 12 Tons.

NEW YORK CENTRAL LINES CLASS, H-10 A

BUILT BY

AMERICAN LOCOMOTIVE COMPANY

NEW YORK

Class, 282 S 335 **Road Number, 156**

GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam.	Stroke		Inside Dia.	Pressure	Length	Width	Number	Diameter	Length
4′-8½″	28″	30″	63″	84 7/16″	210 lbs.	114⅛″	84¼″	253	3¼″	20′-0″

WHEEL BASE			WEIGHT IN WORKING ORDER—POUNDS				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
16′-6″	37′-0″	71′-6½″	29000	248000	58000	335000	200300

FUEL	HEATING SURFACES—SQUARE FT.					GRATE AREA SQ. FT.	MAXIMUM TRACTIVE POWER		FACTOR OF ADHESION	
Kind	Tubes	Fire Box	Arch Tues	Total	Superheater		Engine	Booster	Drivers	Traller
Soft Coal	4287	223	68	4578	1849	66.8	66600 lbs.	11500 lbs.	3.72	5.04

Tender Type, 8-Wheeled. Capacity, Water, 10000 Gals. Fuel, 16 Tons.

NEW YORK CENTRAL LINES CLASS, H-10 B

BUILT BY
AMERICAN LOCOMOTIVE COMPANY
NEW YORK

Class, 282 S 337 — **Road Number, 340**

GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam.	Stroke		Inside Dia.	Pressure	Length	Width	Number	Diameter	Length
4'-8½"	28"	30"	63	84⅝"	200 lbs.	114⅛"	84⅛"	53 192	2¼" 3½"	20'-0"

WHEEL BASE			WEIGHT IN WORKING ORDER POUNDS				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
16'-6"	37'-0"	78'-5"	32500	246000	58500	337000	276000

FUEL	EVAPORATING SURFACES SQUARE FT					SUPERHEATING SURFACE SQUARE FT	GRATE AREA SQ FT	MAXIMUM TRACTIVE POWER		FACTOR OF ADHESION	
Kind	Tubes	Flues	Fire Brick Tubes	Total				Engine	Booster	Drivers	Trailer
Soft Coal	672	3501	75	34	4282	1020	69.4	63500 lbs	11200lbs	3.87	5.22

Fuel 18 Tons

NEW YORK CENTRAL LINES CLASS, L-1 B

BUILT BY
AMERICAN LOCOMOTIVE COMPANY
NEW YORK

Class, 4-8-2 S 343

Road Number, 2500

GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam.	Stroke		Inside Dia.	Pressure	Length	Width	Number	Diameter	Length
4′-8½″	28″	28″	69″	80″	190 lbs.	114¼″	84¼″	216 45	2¼″ 5½″	21′-6″

WHEEL BASE			WEIGHT IN WORKING ORDER—POUNDS				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
18′-0″	38′-11″	72′-9″	52500	243000	56500	343000	166500

FUEL	HEATING SURFACES—SQUARE FT.						GRATE AREA SQ. FT.	MAXIMUM TRACTIVE POWER	FACTOR OF ADHESION
Kind	Tubes	Flues	Fire Box	Arch Tubes	Total	Superheater			
Soft Coal	2723	1387	292	28	4430	1212	66.8	51400 lbs.	4.55

Tender Type, 8-Wheeled Capacity, Water, 8000 Gals Fuel, 14 Tons

PLATE NO. XX

NEW YORK CENTRAL LINES CLASS, 3-Cylinder, 2568

FIRST 3-CYLINDER LOCOMOTIVE BUILT IN U.S.

BUILT BY

AMERICAN LOCOMOTIVE COMPANY

NEW YORK

Class, 482 S 368, "Three-Cylinder" Road Number, 2568

GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam.	Stroke		Inside Dia.	Pressure	Length	Width	Number	Diameter	Length
4′-8½″	25″	28″	69″	80″	200 lbs.	114¼″	84¼″	216	3½″	24′-11″

WHEEL BASE			WEIGHT IN WORKING ORDER—POUNDS				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
18′-0″	40′-7″	82′-6″	65600	241600	60800	368000	267800

FUEL	EVAPORATING SURFACES, SQUARE FT				SUPERHEATING SURFACE SQUARE FT.	GRATE AREA SQ. FT.	MAXIMUM TRACTIVE POWER		FACTOR OF ADHESION	
Kind	Tubes	Fire Box	Arch Tubes	Total			Engine	Booster	Drivers	Trailer
Soft Coal	4913	214	28	5155	2159	66.8	64700 lbs.	11000 lbs.	3.73	5.52

Tender, Type 12-Wheeled. Capacity, Water 15000 Gals. Fuel, 16 Tons.

PLATE NO. XXI

NEW YORK CENTRAL LINES CLASS L-2A

AMERICAN LOCOMOTIVE COMPANY.

NEW YORK.

Class, 482 S 363 — Road Number, 2743

BUILT FOR THE NEW YORK CENTRAL.

GAUGE OF TRACK	CYLINDERS		DRIVING WHEEL DIAMETER	BOILER		FIRE BOX		TUBES		
	Diam.	Stroke		Inside Dia.	Pressure	Length	Width	Number	Diameter	Length
4′-8½″	27″	30″	69″	82 7/16″	225 lbs	120⅛″	90¼″	39-180	3½″	20′-6″

WHEEL BASE			WEIGHT IN WORKING ORDER—POUNDS				
Driving	Engine	Engine & Tender	Leading	Driving	Trailing	Engine	Tender
18′-0″	42′-0″	84′-7″	60000	242000	60500	362500	280500

FUEL	EVAPORATING SURFACES. SQUARE FT					SUPERHEATING SURFACE SQUARE FT.	GRATE AREA SQ. FT.	MAXIMUM TRACTIVE POWER		FACTOR OF ADHESION	
Kind	Tubes	Flues	Fire Box	Arch Tubes	Total			Engine	Booster	Drivers	Trailer
Soft Coal	729	3366	318	36	4449	1938	75.3	60000 lbs.	12700 lbs.	4.03	4.76

Tender Type, 12-Wheeled. Capacity, Water, 15000 Gals Fuel, 21 Tons

ORDER No. S-1530

March, 1926